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ABSTRACT

This guide is designed to provide adult learners with hands-on activities and demonstrations to develop skills in physical science. The guide consists of four units on the following topics: introduction to chemistry, introduction to atomic structure, chemical formulas and equations, and common chemicals. Each unit contains some or all of the following: behavioral objectives, list of supplies needed for the unit, definitions of vocabulary, concepts covered in the unit, background information needed for the activities, activity sheets, and answer keys. Each activity sheet includes a list of materials needed for the activity, a detailed procedure, question(s) pertaining to the activity, and explanation/discussion of the reaction occurring during the activity. The activities presented in the curriculum may be incorporated into any science program with only slight modifications, and most activities require only common items that are readily available in kitchens and/or grocery stores. Concluding the guide are a pretest/posttest and answer key, and report describing the curriculum development project. Contains 15 references. (MN)

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BEYOND THE GED WITH PHYSICAL SCIENCE

A hands-on science curriculum

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BEYOND THE GED WITH PHYSICAL SCIENCE

An introduction to teachers:

The following curriculum was designed to provide adult learners with hands-on activities and demonstrations to develop skills in the area of physical science. The curriculum consists of four units: 1. introduction to chemistry, 2. introduction to atomic structure, 3. chemical formulas & equations, and 4. common chemicals. Each unit begins with an outline of objectives followed by a list of supplies needed for the unit. Vocabulary words are defined and concepts are stated at the beginning of each lesson providing the teacher with the necessary background for the activities. The teacher has the flexibility to use a variety of methods and strategies in the presentation of the science concepts.

This curriculum can be incorporated into any science program with very few necessary modifications. Most of the activities require only "kitchen" or "grocery store" items making the curriculum suitable for a variety of locations. Although this curriculum was designed with the target audience being GED level students, the lessons can be simplified for most learners regardless of their ability levels.

It is the goal of this project to promote physical science skills through active participation for all learners.

Beyond the GED With Physical Science

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UNIT ONE

Introduction to Chemistry

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Beyond the GED With Physical Science

Unit One - INTRODUCTION TO CHEMISTRY - Objectives

Matter:

1. Define matter.
2. Name some common elements and compounds.
3. Distinguish among elements, compounds, and mixtures.

Physical Properties:

4. Describe the three phases of matter.
5. Relate the phases of matter to the arrangement of particles within the matter.
6. Describe the energy changes that occur during changes of phase.
7. Describe what occurs at the freezing point, melting point, and boiling point of a substance.
8. Explain the affects of atmospheric pressure, the relationship between pressure and volume, and the relationship between pressure and temperature.
9. List the standard physical properties of matter.
10. Explain surface tension.

Physical/Chemical Changes:

11. Distinguish between a chemical change and a physical change.
12. List various types of physical changes.
13. Contrast a solution and a suspension.

Physical/Chemical Changes:

14. Distinguish between solute and solvent in a solution.
15. State the law of definite composition.
16. Describe the energy changes in a chemical reaction.
17. Explain the rate of reaction.
18. Give examples of variables that affect the rate of reaction.
19. Define catalyst.

INTRODUCTION TO CHEMISTRY

Unit One - Supply List - 28 Activities

meter or yard stick
large, clear container
4 glasses the same size
medicine dropper
tape measure
2 graduated cylinders
2 medium size containers
spring scale
3 teaspoons
spatula
balance or scale
glass bottle with narrow neck
jar with lid
tongs
2 plastic soft drink bottles
aluminum soft drink can
funnel
Erlenmeyer flask

rubbing alcohol
food coloring
salt
pepper
clear liquid soap
oil
Alka Seltzer tablets
sugar cubes
baking powder
vinegar
peeled, hard-boiled egg
2 raw eggs

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heat source (electric burner & pan to heat water)
hot water
ice
water

balloons
string
tissue
perfume
masking tape
clock or watch
3 stones, different sizes
sewing needle
straight pin
rubber bands
paper clips
toothpicks
several sheets of paper
aluminum foil
matches
soil
sand
pebbles
cigarette ashes
long/thin boards
newspaper
index cards
pennies (50 per group)
towel
styrofoam cups

INTRODUCTION OF CHEMISTRY

Matter: anything that occupies space and has mass.

Activity: **Observing That Air Is Matter**
demonstrates that air occupies space.

Activity: **Air is Matter**
demonstrates that air has mass.

OBSERVING THAT AIR IS MATTER

Materials needed:

a glass
a tissue
a pail of water

Procedure:

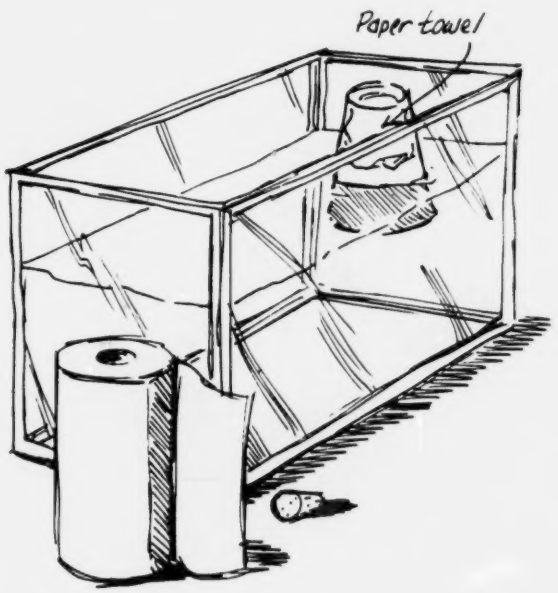
1. Stuff a tissue into the bottom of a glass.
2. Turn the glass upside down and push it straight down into the pail of water.
3. Pull the glass straight out of the water and feel the tissue.

Questions:

1. Did the tissue feel wet?
2. Why did water not enter the glass?
3. How does this activity show that air is matter?

Reaction:

Air is matter and takes up space. Since the glass was full of air the water could not enter the glass and the tissue remained dry.



AIR IS MATTER

Materials needed:

2 balloons
meter or yard stick
string
pin

Procedure:

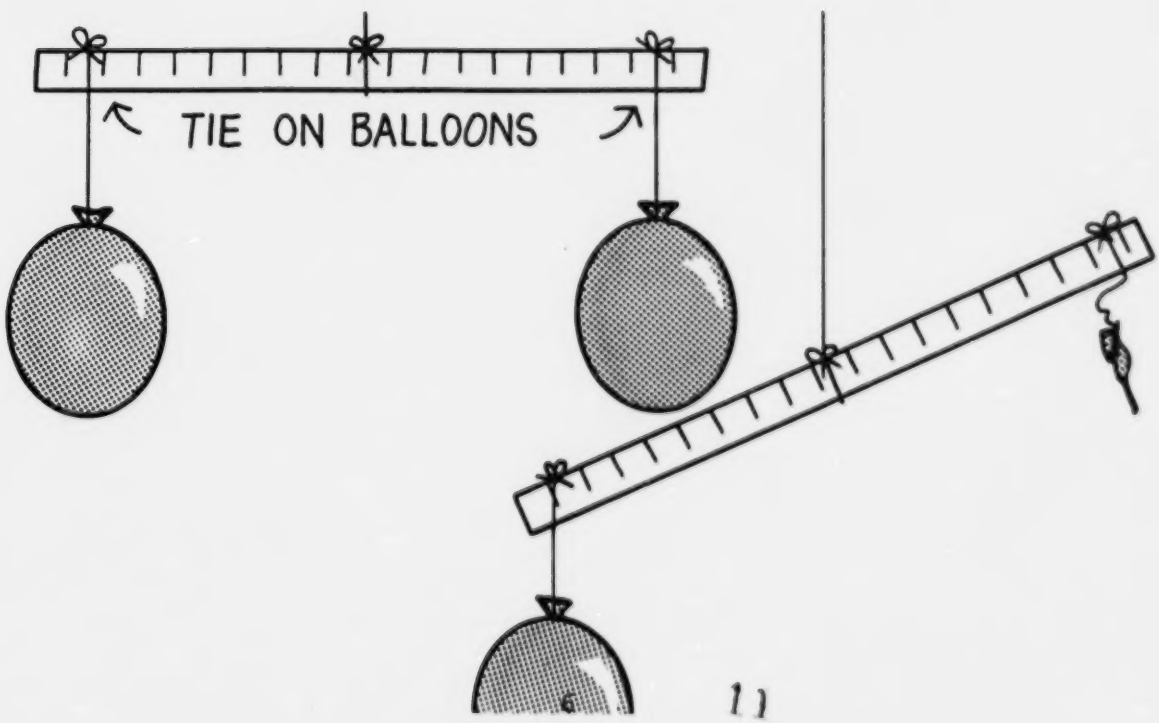
1. Blow up two balloons with air.
2. Tie a balloon on each end of a yardstick.
3. Suspend the yardstick in the center from string.
4. Move the balloons so they are balanced and the stick is level.
5. Puncture one balloon near the opening with a pin allowing the air to escape. Be careful not burst the balloon.
6. Observe that the yardstick in no longer balanced.

Questions:

1. What has caused the yardstick to no longer be balanced?

Reaction:

When the one balloon is filled with air it makes the one end of the yardstick heavier. This demonstrates that air has mass. It also shows that air occupies space.



INTRODUCTION TO CHEMISTRY

Matter: anything that occupies space and has mass. All matter can be divided into three types: elements, compounds, and mixtures.

Elements: material that is made up of one kind of matter; an element cannot be broken into any simpler material by ordinary means; Scientists know of 108 elements.

Compounds: made of two or more elements that are chemically combined. Elements lose their individual characteristics when they join to make a compound.

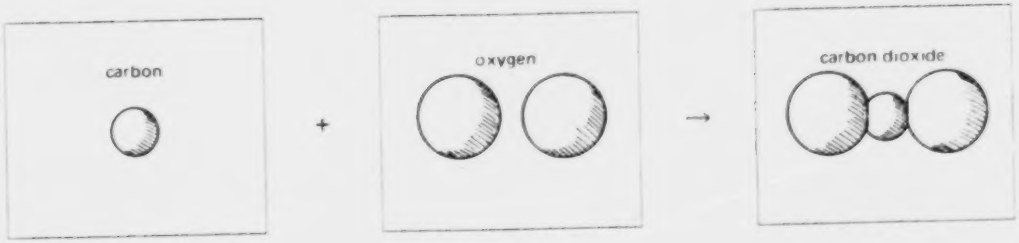
Mixtures: matter made up of two or more materials mixed together in which each retains its own properties. Unlike a compound, the amount of each ingredient can differ from mixture to mixture. The ingredients in a mixture can be rather easily separated.

Common Elements	Symbols
Aluminum	Al
Nickel	Ni
Carbon	C
Oxygen	O
Chlorine	Cl
Gold	Au
Silver	Ag
Hydrogen	H
Nitrogen	N
Sodium	Na

INTRODUCTION TO CHEMISTRY

Common Compounds:

Water	H O	(Hydrogen & Oxygen)
Salt	NaCl	(Sodium & Chlorine)
Carbon Dioxide	CO	(Carbon & Oxygen)



Activity: **Distinguishing Between a Compound and a Mixture** demonstrates some of the differences between compounds and mixtures.

INTRODUCTION OF CHEMISTRY

Distinguishing Between a Compound and a Mixture

Materials needed:

2 glasses for each student
rubber bands
paper clips
water

Procedure:

1. Give each student a glass filled with a mixture of two common objects (rubber bands and paper clips).
2. Ask the students to separate the items.
3. Then give each student a glass of water.
4. Ask the students if they can physically separate the water into hydrogen and oxygen.
5. Ask students to identify each glass as containing a mixture or a compound.

Reaction:

The glass of common objects can be physically separated and each object maintained its own properties. This indicates a mixture. The water can not be separated into hydrogen and oxygen by ordinary means. Water is a compound.

INTRODUCTION TO CHEMISTRY

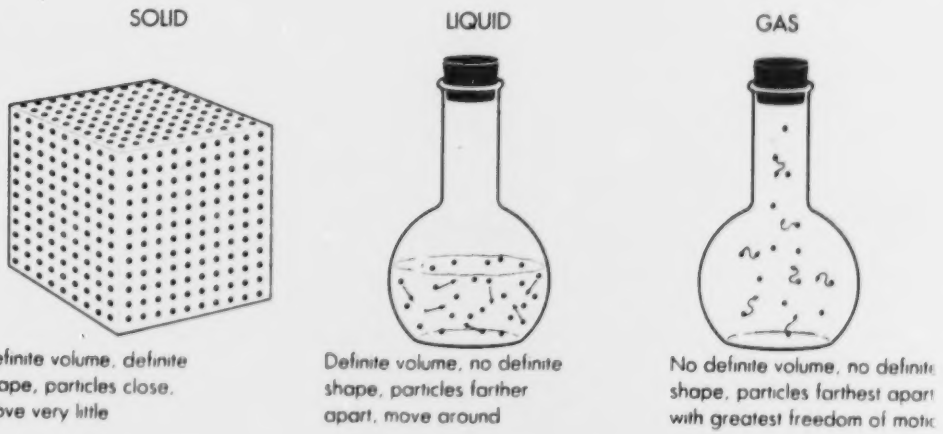
Physical Properties

Three Phases of Matter:

Solid: matter which has a definite volume and shape; particles are close together, particles move very little.

Liquid: matter which has a definite volume but no definite shape; takes the shape of its container; particles are farther apart and move around more rapidly.

Gas: matter which has no definite volume and no definite shape; gases fill the entire volume and shape of the container they are in; particles are far apart, with greatest freedom of movement.


SOLID
LIQUID
GAS
Definite volume, definite shape, particles close, move very little
Definite volume, no definite shape, particles farther apart, move around
No definite volume, no definite shape, particles farthest apart with greatest freedom of motic

Activity: **Spaces Between Molecules Of A Solid** demonstrates that there are tiny spaces between the molecules of a solid.

Activity: **One And One Do Not Always Equal Two** demonstrates that there are spaces between the molecules of a liquid.

Complete the Chart: THREE STATES OF MATTER

SPACES BETWEEN MOLECULES OF A SOLID

Materials needed:

balloon
medicine dropper
perfume
masking tape
tape measure

Procedure:

1. Put about 10 drops of perfume inside the balloon. Be careful not to get any perfume on the outside of the balloon.
2. Carefully blow up the balloon and tie it.
3. Put two pieces of masking tape on the balloon to use for measuring horizontally. Measure and record the distance between the pieces of tape.
4. Sniff the outside of the balloon to see if you can smell any perfume.
5. After several day, measure and record distance between pieces of tape. Sniff the outside of the balloon to see if you can smell any perfume.

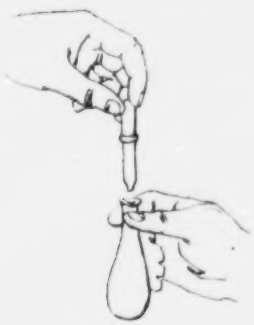
Questions:

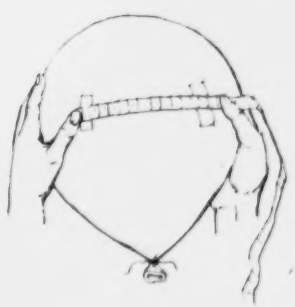
1. What changes occurred in the balloon?
2. What may have caused these changes?
3. Could you smell any perfume on the outside of the balloon? If so, why?
4. What does this activity show about the way solid matter is put together?

Reaction:

After several days the balloon gets smaller, indicating that the air inside escaped in some way. If the balloon was tied securely, the air molecules must have passed through the spaces among the molecules of the balloon.

Most students will be able to smell perfume on the outside of the balloon after a few days. This indicates that the perfume molecules also passed through the spaces among the molecules of the balloon. This activity shows that even solid matter has spaces among it particles - atoms or molecules.





ONE AND ONE DO NOT ALWAYS EQUAL TWO

Materials needed:

2 graduated cylinders
rubbing alcohol
water

Procedure:

1. Put 20 mL of water in a graduated cylinder.
2. Put 20 mL of rubbing alcohol in the other graduated cylinder.
3. Pour the water into the graduated cylinder with the rubbing alcohol.
4. Observe how much liquid is in the cylinder.

Questions:

1. Did 20 mL added to 20 mL make 40 mL?
2. Where did the missing liquid go?

Reaction:

Matter is made of atoms and molecules. The molecules of water and the molecules of alcohol have spaces between them. When the two liquids are mixed, molecules of water get into the spaces between the alcohol molecules, and the alcohol molecules get into the spaces between the water molecules. This would be like filling a large basket with baseballs and then dropping marbles in between the spaces of the baseballs. The baseballs represent larger molecules and the marbles represent smaller molecules.

INTRODUCTION TO CHEMISTRY

Physical Properties

Complete the Chart: Three States of Matter

State	Have Mass	Take Up Space	Take Up Definite Amount Of Space	Have Definite Shapes	Spread Out To Take Shape Of Container	Small Amounts Fill Large Containers	Can Be Invisible
Solids							
Liquids							
Gases							

ANSWER KEY

INTRODUCTION TO CHEMISTRY

Physical Properties

Complete the Chart: Three States of Matter

State	Have Mass	Take Up Space	Take Up Definite Amount Of Space	Have Definite Shapes	Spread Out To Take Shape Of Container	Small Amounts Fill Large Containers	Can Be Invisible
Solids	*yes*	*yes*	*yes*	*yes*	*no*	*no*	*no*
Liquids	*yes*	*yes*	*yes*	*no*	*yes*	*no*	*no*
Gases	*yes*	*yes*	*no*	*no*	*yes*	*yes*	*yes*

INTRODUCTION TO CHEMISTRY

Physical Properties

Condensation: change from a gas to a liquid.

Evaporation: change from a liquid to a gas at the surface of the liquid.

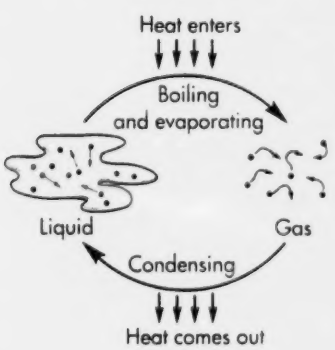
Freezing: change from a liquid to a solid.

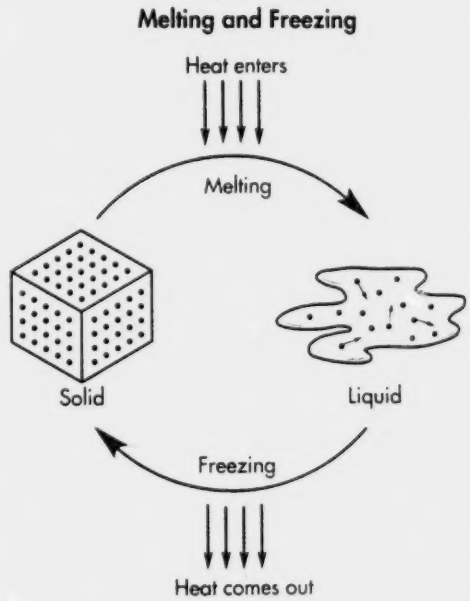
Melting: change from a solid to a liquid.

When matter changes from one state to another, it either loses or gains heat.

Heat gives the particles in more energy, so they can move about with greater speed. When this happens, a solid will **melt** into a liquid and a liquid will **evaporate** into a gas.

Removing heat reduces the energy available to the particles. The particles come together and move with less speed. When this happens, a gas will **condense** to a liquid and a liquid will **freeze** to a solid.





Activity: **Temperature Affects Particle Motion** demonstrates increased/decreased movement of particles with a change in temperature.

TEMPERATURE AFFECTS PARTICLE MOTION

Materials needed:

3 glasses
medicine dropper
food coloring
hot water
cold water
clock or watch

Procedure:

1. Using equal amounts of hot and cold water, fill one glass.
2. Put hot water in a second cup to the same level as the water in the first cup.
3. Put cold water in the third cup to the same level.
4. Put a single drop of food coloring in each cup.
5. Record the time when the food coloring is added. Do not shake or move the cups after the food coloring has been added.
6. Watch the cups for 10 minutes. Record the time it takes for the food coloring to spread throughout each cup.

Questions:

1. How long did it take to color all the water in each cup?
2. You probably saw streamers of coloring in the cups. In which cup did you see streamers for the longest time?
3. In which cup of water did the color spread the fastest?
4. In which cup of water did the color spread the slowest?

Reaction:

The temperature affects the motion of particles by speeding up particle movement with an increase of temperature. A decrease in temperature slows down particle movement.

INTRODUCTION TO CHEMISTRY

Atmospheric pressure: The air all around us consists of molecules of gases that are in constant motion. The constant motion of these particles produces a pressure that we call atmospheric pressure. Fortunately, air pressure is exerted in all directions. If air pressure were exerted only from above, for example, we would be instantly crushed by tons of air. Atmospheric air exerts a pressure of approximately 15 lb/in^2.

Activity: **Breaking A Board**
demonstrates the effect of atmospheric pressure.

Activity: **Differences in Pressure**
demonstrates the effect of atmospheric pressure.

Activity: **Charles' Law: The Relationship Between Volume And Temperature Of A Gas**
demonstrates that decreasing the temperature of a gas will decrease its volume.

Activity: **The Cartesian Diver: An Application of Boyle's Law**
demonstrates that increasing the pressure on a gas will decrease its volume.

Activity: **Behavior Of Gases And The Boiling Egg**
demonstrates that increasing the temperature of a gas will increase its pressure if the volume remains constant.

Activity: **Egg In A Bottle**

Activity: **The Collapsing Soft Drink Can**

Activity: **The Collapsing Plastic Soft Drink Bottle**

Activity: **Temperature and Pressure Relationships**

Activity: **Properties of Gases: Pressure And Suction**

BREAKING A BOARD

Materials needed:

full sheet of newspaper
long thin piece of wood about one meter long

Procedure:

1. Put an old meter stick or yard stick on a sturdy table top with about 6 inches of it projecting over the edge of the table.
2. Cover the part of the stick that is on the table with a full sheet of newspaper.
3. Give the end of the stick a sharp blow with your hand.

Questions:

1. Did the stick break?
2. What explanation can we give for the stick breaking?

Reaction:

Atmospheric air exerts a pressure approximately 15 lb/in^2. Therefore, when spread open, the newspaper has almost 10,000 lb of air pressing on it! If you slowly lift the paper, allowing time for air to flow beneath it, the pressure will be equal on both sides and will not hold the paper in place. However, if you suddenly strike the board beneath the paper in an attempt to raise the paper, the tremendous pressure of atmospheric air on the upper surface will hold the paper in place and even break the board.

DIFFERENCES IN PRESSURE

Materials needed:

smooth-rimmed glass
small square of cardboard
water

Procedure:

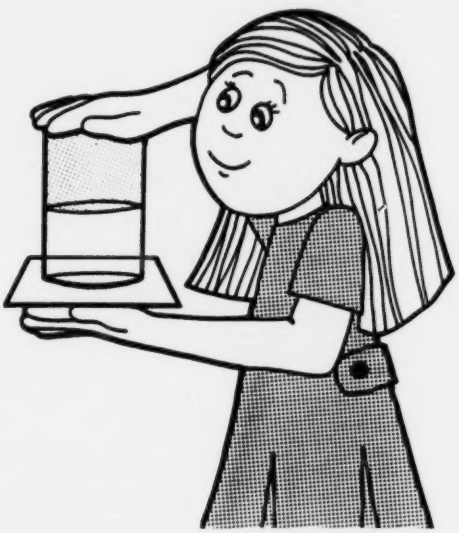
1. Completely fill the glass with water.
2. Slide the piece of cardboard over the mouth of the glass to remove excess water and to cover the glass.
3. Press down on the cardboard with your fingers and hold it, and turn the glass upside-down.
4. Carefully remove your fingers from the cardboard.
5. Observe.

Questions:

1. What keeps the cardboard in place?

Reaction:

The pressure of the air on the outside of the container is greater than the pressure of the water from the inside. The cardboard is held in place by external air pressure.



CHARLES' LAW: THE RELATIONSHIP BETWEEN VOLUME AND TEMPERATURE OF A GAS

Materials needed:

3 balloons
pan of ice water
pan of hot water

Procedure:

1. Partially inflate three balloons to the point that they just begin to expand. Tie securely.
2. Leave one balloon for reference. Place one balloon on the surface of a pan of ice water.
3. Place the third balloon on the surface of a pan of hot water.
4. Observe the effect of temperature on the volume of the gas in the balloons.
5. Remove both balloons and allow them to come to room temperature.

Questions:

1. What happened to the balloon placed on the ice water?
2. What happened to the balloon placed on the hot water?
3. What happened when the balloons returned to room temperature?
4. Why do the balloons behave as they do in hot & cold water?
5. What effect does temperature have on the volume of a gas?

Reaction:

As the temperature decreases, the average kinetic energy of the gas inside the balloon decreases, which decreases the pressure inside the balloon. When the balloon is heated, the volume increases as the internal pressure increases.

THE CARTESIAN DIVER: AN APPLICATION OF BOYLE'S LAW

Materials needed:

large plastic soft drink bottle
water
medicine dropper

Procedure:

1. Remove the label from the outside of a large plastic soft drink bottle.
2. Fill the bottle to the top with water.
3. Place an empty medicine dropper in the bottle. Be sure that the bottle is full to the top.
4. Put the cap on the bottle and tighten.
5. Gently press the sides of the plastic container. Notice that the water level will rise in the dropper and the dropper will slowly begin to sink.
6. Release the pressure, and the water level in the dropper will become lower and the dropper will rise again.
7. Pass the "Cartesian Diver" around your class.

Questions:

1. What steps are needed to cause the dropper to sink?
2. What happens to the air in the dropper?

Reaction:

According to Boyle's law, increasing pressure on a gas will decrease its volume. Pressing on the sides of the plastic bottle increases the pressure on the water and forces it into the dropper. This increase in water volume reduces the volume of air in the dropper. The dropper is now heavier and it sinks. When the pressure is released, the opposite effect occurs.

BEHAVIOR OF GASES AND THE BOILING EGG

Materials needed:

two raw eggs
straight pin
pencil
large beaker
burner/ heat source
water

Procedure:

1. The beaker should be large enough for two eggs to fit inside easily.
2. Fill the beaker two-thirds full with water and heat until it is near boiling.
3. Using a pencil, mark one egg with a large "X". Carefully punch a small hole in the large end of this marked egg with a straight pin. Twist the pin as you make the hole to avoid breaking the shell.
4. Do nothing to the other egg; it will serve as a control.
5. Carefully place both eggs in the beaker of hot water.
6. Observe both eggs closely.

Questions:

1. Do you see tiny air bubbles forming around the control egg?
2. Is a steady stream of bubbles coming from the hole in the marked egg?
3. What do you think is happening?

Reaction:

The eggshell is slightly porous, which means that it has many small holes. When the air inside the egg is heated, the pressure of the gas increases, and some of the air is forced through these tiny pores. What would happen if the egg did not contain these pores? The pressure would cause the eggshell to crack and break. Sometimes breakage occurs anyway when the temperature is rapidly increased, for example, by placing the egg immediately in boiling water.

If we place a hole in the shell, the increased pressure of air causes the expanding volume of gas to leave the shell faster by forming a stream or jet of air bubbles. This situation allows us to observe direct evidence that increasing the temperature of the gas in the egg results in an increase in gas pressure.

EGG IN A BOTTLE

Materials needed:

peeled, hard-boiled egg
qt. bottle
hot water

Procedure:

1. Select a 1-qt bottle with a mouth just small enough that as egg, when placed on the mouth, will not fall through.
2. Fill the bottle with hot water. Empty the bottle. Now carefully fill the bottle with water that is almost boiling. Let the water sit in the bottle for about 5 seconds, then empty the bottle.
3. Immediately place a peeled, hard-boiled egg, small end down, into the mouth of the bottle.
4. After 10 - 20 seconds, the egg will be pushed into the bottle with a "plop".
5. Challenge the class to explain how the egg got into the bottle. Then ask for suggestions for removing the egg intact.
6. To remove the egg, turn the bottle upside down and let the egg plug the neck. Blow as hard as you can into the mouth of the bottle and the egg will be pushed out.

Questions:

1. What change takes place in the air inside the bottle that causes the egg to be forced into the bottle?
2. Why does the egg stay in the bottle when the bottle is inverted?
3. Why does blowing into the bottle force the egg out of the bottle?

Reaction:

The hot water warms the bottle so that the air inside the bottle is heated. With either end of the egg plugging the mouth, the air inside the bottle is isolated from the air outside the bottle. As the air inside the bottle cools, the pressure inside decreases. The air pressure outside the bottle is greater and pushes the egg into the bottle. When you blow into the bottle, the pressure inside becomes greater than the pressure outside, so the egg pops out.

Sometimes this demonstration is done by burning a small piece of paper inside the bottle. This leaves ashes, which coat the egg and make it messy to remove later.

THE COLLAPSING SOFT DRINK CAN

Materials needed:

aluminum soft drink can
water
heat source
tongs
trough containing water

Procedure:

1. Place about 5 mL of water in an empty aluminum soft drink can.
2. Boil the water in the can vigorously for several minutes, until the can is filled with water vapor.
3. Carefully (use tongs) and quickly invert the can and place it, top down, into a trough containing about 1 inch of water.
4. Observe.

Questions:

1. Why did the can collapse?

Reaction:

The water cools the can and condenses the steam inside. The sudden reduction in pressure in the can causes the can to collapse.

THE COLLAPSING PLASTIC SOFT DRINK BOTTLE

Materials needed:

2 liter plastic soft drink bottle
hot water
funnel

Procedure:

1. Using the funnel, fill the bottle to the top with hot (almost boiling) water.
2. Immediately pour the water from the bottle and quickly screw the cap tightly on the bottle.
3. Place the bottle in full view of your class and observe.

Questions:

1. Why did the bottle collapse?

Reaction:

The hot water inside the bottle heats the air in the bottle, which greatly reduces the pressure inside the container, when the bottle is capped and the air cooled. The pressure outside is greater than the pressure inside, which causes the bottle to collapse.

TEMPERATURE AND PRESSURE RELATIONSHIPS

Materials needed:

Erlenmeyer flask with a narrow mouth
water
heat source
towel
balloon

Procedure:

1. Place about 5 mL of water in the flask.
2. Heat the flask until the water boils down to a volume of about 1 mL.
3. Remove the flask from the heat, hold it with a towel, and immediately place the open end of a colored balloon over the mouth of the flask. Be careful with the hot flask.
4. Observe the effect as the flask cools. The balloon will be sucked into the flask.
5. To remove the balloon, heat the flask.

Questions:

1. Why is the balloon sucked into the flask?
2. Why is it necessary to boil the water?
3. How can you remove the balloon without breaking the flask?

Reaction:

As the flask cools, the vapor pressure inside decreases. Because the pressure outside the flask is greater, the balloon is sucked (pushed) into the flask.

You will get better results is you partially inflate the balloon before attaching it to the hot flask.

PROPERTIES OF GASES: PRESSURE AND SUCTION

Materials needed:

several balloons
styrofoam cups

Procedure:

1. Obtain several balloons that will easily inflate to 6 - 8 inches.
2. Hold two cups with the deflated balloon between them (you may want a student to assist you).
3. Blow into the balloon and inflate it with one breath.
4. Hold up the balloon with the attached cups and ask for an explanation.

Questions:

1. Can you explain this phenomenon?

Reaction:

As the balloon is inflated, air pressure forces the sides of the balloon against the cups with such force that the cups adhere to the balloon. This sequence and the friction between the balloon and the rim of the cup create a suction effect on the cups.

INTRODUCTION TO CHEMISTRY

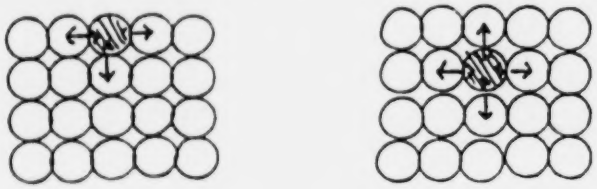
Physical Properties

The standard physical properties of matter are:
phase or **state** (solid, liquid, gas)
melting point
boiling point
density

Density: mass of a material in a standard volume, such as grams per cubic centimeter.
Every substance has a density that can be measured. The density of a substance is always the same. Density does not depend on the size or shape of the substance. Density can be used to identify different substances.

Activity: **Stone Soup**
demonstrates how the weight of an object varies with the density of the water.

Surface Tension: the energy required to increase the surface area of a liquid; causes the surface to act as if it has a membrane; partly due to the fact that surface molecules are only pulled inward, whereas other molecules in the liquid are pulled equally in all directions.



This unbalanced force tends to pull the water molecules back in the liquid and thus forms the convex surface.

Activity: **Pennies In The Glass**
demonstrates that surface tension acts like a stretched membrane.

Activity: **Surface Tension of Water: The Floating Needle**
demonstrates the surface tension of water.

Activity: **Magic Pepper**
demonstrates how a wetting agent lowers the surface tension of water.

Activity: **Changing Surface Tension - Oil And Water**
demonstrates how a change in surface tension affects the shape of a floating rubber band.

STONE SOUP

Materials needed:

2 containers the same size
water
string
spring scale
salt
spoon
3 stones, different sizes

Procedure:

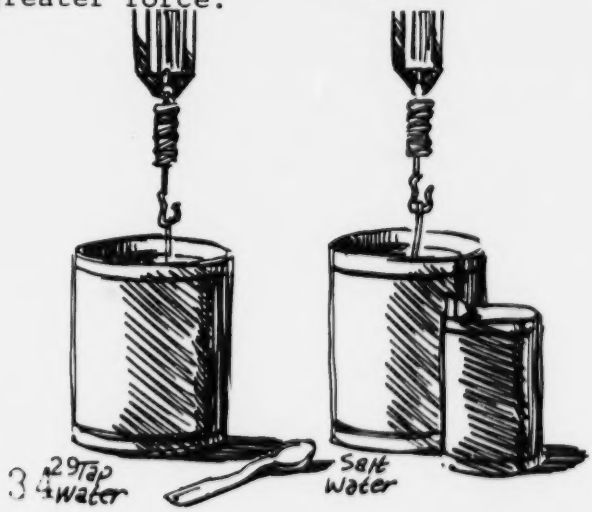
1. Fill the containers with the same amount of water within 2 inches of the top.
2. Add salt to one container until the water is saturated.
3. Tie a piece of string to each of the stones and weigh the stones one at a time by tying the other end of the string to the spring scale.
4. Have students record the weights of the three stones.
5. Submerge each stone in water and record the new weights. The stones should not touch the bottom.
6. Submerge each stone in salt water and record the new weights.

Questions:

1. What can we conclude about the weight of an object submerged in water?
2. How can you explain the difference in the weights of the stones submerged in the two types of water?

Reaction:

The upward push of water causes some materials to float and others to weigh less when submerged. The density of the water determines the amount of push it is capable of providing. Because salt water is more dense than tap water, it pushes up with a greater force.



PENNIES IN THE GLASS

Materials needed:

Large drinking glass
Water
Pennies (about 50 per group)

Procedure:

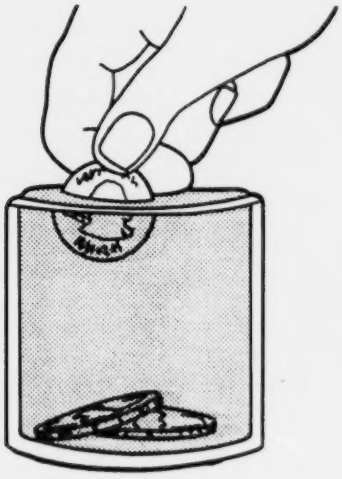
1. Carefully fill your glass with water until it is full but not overflowing.
2. Carefully drop a penny into the glass of water. Hold the penny just above the surface of the water and drop it edge down in the center of the glass.
3. Continue dropping the pennies, one at a time, into the glass until it overflows.

Questions:

1. How many pennies could you drop into the glass before it overflowed?
2. How can you explain this phenomenon?
3. Do you think that other liquids, such as alcohol, would behave the same way? Try it.

Reaction:

Because of surface tension, water molecules on the surface of the water are attracted to each other in an attempt to pull the water molecules back into the liquid. This attraction is so strong that the water will actually form a curved surface above the glass (convex surface) as pennies are added to displace small volumes of water.



SURFACE TENSION OF WATER: THE FLOATING NEEDLE

Materials needed:

large beaker or pan of water
tissue paper
sewing needle
spatula

Procedure:

1. Fill a large beaker or pan almost full of water.
2. Place a sewing needle on top of a small piece of tissue paper.
3. Place a large spatula beneath the tissue paper and carefully lower it and the needle onto the water. The paper and needle will float. Soon, the paper will become soaked and sink, and the needle will be left floating on the surface.
4. After discussing the role of surface tension, add 1 drop of soap solution to the surface of the water.
5. Observe that the needle sinks in a few seconds.

Questions:

1. Why does the heavy needle float?
2. What is Surface Tension?

Reaction:

Surface Tension of a liquid is the energy required to increase the surface area. This tension causes the surface to act as if it had a membrane, or skin. This property is partly due to the fact that surface molecules are only pulled inward, whereas other molecules in the liquid are pulled equally in all directions.

The needle is denser than water, so if pushed under, the needle will sink. On the surface, however, energy would be required to increase the water surface enough for the needle to submerge, so it floats.

Surface tension also allows some insects (water bugs) to walk on water, even though they are heavier than water.

MAGIC PEPPER

Materials needed:

pan
water
pepper
soap

Procedure:

1. Fill the pan with water.
2. Sprinkle pepper on the surface of the water.
3. Place your finger into the water through the floating pepper.
4. Remove your finger and notice that it will be coated with pepper.
5. Coat your finger with a thin film of moistened soap.
6. Again place your finger through the pepper.
7. Observe.

Questions:

1. How did the pepper react to your finger the second time?
2. What causes the pepper to move and/or sink?

Reaction:

The high surface tension of water acts somewhat like an elastic membrane stretched across the water and prevents the pepper from sinking. A wetting agent (soap) lowers the surface tension of the water and allows the particles of pepper to drop through the surface.

CHANGING SURFACE TENSION - OIL AND WATER

Materials needed:

pan
oil
water
rubber band
toothpick

Procedure:

1. Nearly fill the pan with water.
2. Float the rubber band on the water surface.
3. Observe that it keeps the shape it normally has when not stretched.
4. With a toothpick, transfer a little oil to the water surface inside the rubber band.
5. Observe the shape of the rubber band.

Questions:

1. What caused the rubber band to change shape?

Reaction:

The rubber band takes the shape of a circle because the surface tension outside it is now greater - exerts more pull on the rubber band - than the surface tension inside it.

INTRODUCTION TO CHEMISTRY

Physical/Chemical Changes

Physical Change: change in the form of a substance but not in its composition, such as melting, tearing, and dissolving.

Chemical Change: change in which one or more old substances disappear and one or more new substances appear.

Examples of Physical Changes:

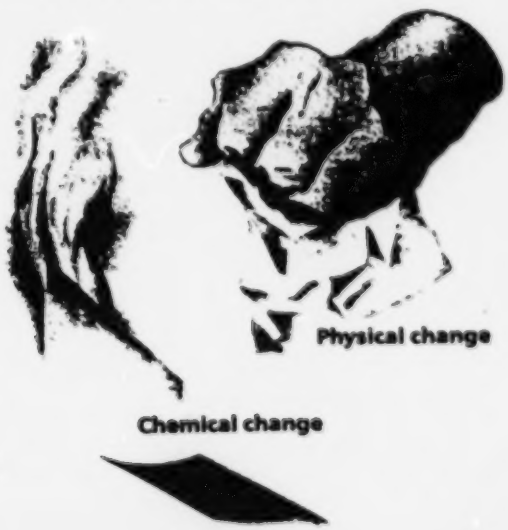
tearing a sheet of paper
breaking a rock into powder and pebbles
mixing iron filings and sulfur powder
dissolving sugar in water
changing water to ice
cutting an apple into pieces

Activity: **Observing A Physical Change**
demonstrates the phase changes of water

Example of Chemical Changes:

burning a piece of paper
rusting of iron
digestion of food

Activity: **Observing A Chemical Reaction**
demonstrates a chemical change by burning paper



OBSERVING PHYSICAL CHANGES

Materials needed:

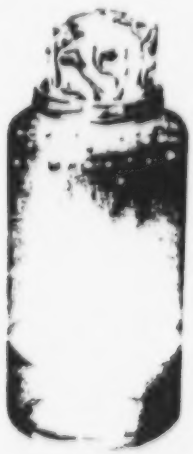
glass bottle or jar with narrow neck
ice cubes
hot water

Procedure:

1. Put a small amount of hot water into a bottle or jar.
2. Place an ice cube over the top of the bottle so that the ice cube will not fall in.
3. Observe what you see coming from the surface of the hot water.
4. Observe the bottle for a few minutes and note what you see happening near the top of the bottle.
5. Watch for another minute or two. Note if you see anything fall from the top of the bottle.

Questions:

1. What did you observe coming from the surface of the hot water?
   What caused this to happen?
2. What did you see near the top of the bottle?
   What caused this to happen?
3. Did you see anything falling inside the bottle?
   If so, explain what you saw and how it was produced.



OBSERVING A CHEMICAL REACTION

Materials needed:

sheet of paper
aluminum foil
matches
a balance

Procedure:

1. Use the balance to find the mass of a sheet of paper.
   Record the mass.
2. Place the paper on a piece of aluminum foil.
   Use the matches to burn the paper to ashes.
3. Measure and record the mass of the ashes.

Questions:

1. How do the mass of the paper and the mass of the ashes compare?
2. How can you account for the difference in mass?

INTRODUCTION TO CHEMISTRY

Physical/Chemical Changes

Mixture: two or more elements or compounds that are not chemically combined.

Solution: mixture made when a material dissolves in water; solutions are clear and material does not settle.

Solute: substance that is dissolved.

Solvent: substance in which solute is dissolved.

Suspension: mixture made when a material is stirred with water but does not dissolve; suspensions are cloudy and material settles to the bottom; particles of a suspension settle by weight.

Examples of a **solution:**

water and sugar
water and salt
instant coffee or ice tea

Examples of a **suspension:**

water and sand
water and soil
salad dressings (oil)
orange juice
vegetable soup

Complete the Chart: LIQUID SOLUTIONS

Activity: **Suspensions Settle**
demonstrates how the mixtures settle according to weight

INTRODUCTION TO CHEMISTRY

Physical/Chemical Changes

Complete the Chart. **Liquid Solutions**

Ten mixtures you are familiar with are listed below. Some are liquid solutions, some are not. Think about each mixture, then fill in the boxes.

Mixture	Do the substances dissolve? (yes or no)	If the substances dissolved name the solute or solutes	solvent
1. sugar water			
2. muddy water			
3. salty water			
4. pebbles in water			
5. instant coffee drink			
6. orange juice			
7. oil & water			
8. instant tea drink			
9. ocean water			
10. vegetable soup			

ANSWER KEY

INTRODUCTION TO CHEMISTRY

Physical/Chemical Changes

Complete the Chart. **Liquid Solutions**

Ten mixtures you are familiar with are listed below. Some are liquid solutions, some are not. Think about each mixture, then fill in the boxes.

Mixture	Do the substances dissolve? (yes or no)	If the substances dissolved name the solute or solutes	solvent
1. sugar water	*yes*	*sugar*	*water*
2. muddy water	*no*	---	---
3. salty water	*yes*	*salt*	*water*
4. pebbles in water	*no*	---	---
5. instant coffee drink	*yes*	*coffee*	*water*
6. orange juice	*no*	---	---
7. oil & water	*no*	---	---
8. instant tea drink	*yes*	*tea*	*water*
9. ocean water	*yes*	*salts*	*water*
10. vegetable soup	*no*	---	---

SUSPENSIONS SETTLE

Materials needed:

soil
sand
pebbles
water
jar w/lid

Procedure:

1. Put equal parts of sand, soil, and pebbles in jar.
2. Fill to the top with water and put lid on.
3. Shake mixture and observe.
4. Set the jar down and allow the suspension to settle.

Questions:

1. In what order did the mixture settle?
2. What can we state about the order of settlement?

Reaction:

A suspension is a cloudy mixture of two or more substances that settle on standing. The particles of a suspension settle by weight. The heavy parts settle first. Then, the lighter parts. In this suspension the pebbles settle on the bottom and then the sand and soil.

INTRODUCTION TO CHEMISTRY

Physical/Chemical Changes

A **chemical change** can also be called a **chemical reaction.** During a chemical reaction, energy is either given out or taken in, usually in the form of heat. Sometimes, energy in the form of light or electricity can be given out or taken in as well.

Exothermic reaction: releases energy; example - burning wood gives off both light energy and heat energy.

Endothermic reaction: absorbs or takes in energy; example producing plastics requires heat energy to be absorbed, photosynthesis requires plants to absorb light energy.

Activation energy: certain amount of energy required before a reaction can occur; example - burning wood or coal requires a heat source (matches, pilot light) to begin the reaction.

Law of definite composition: chemicals react according to definite combining ratios; elements join together in a definite ratios of mass to make compounds.

Rate of reaction: speed of a reaction; amount of product made in a certain time; may be affected by temperature, particle size, concentration, pressure, or a catalyst.

Catalyst: substance that can increase the rate of reaction without any change to its own composition.

Activity: **How Fast Is The Fizz?**
demonstrates the effects of temperature on the rate of reaction

Activity: **Changing The Rate Of Dissolving**
demonstrates the effects of particle size and movement on the rate of reaction

Activity: **How Does Baking Powder Work?**
demonstrates effects of a catalyst on the rate of reaction

Activity: **Rare Earth Oxides as Catalysts**
demonstrates the use of a catalyst

HOW FAST IS THE FIZZ?

Materials needed:

2 glasses or beakers
hot water
ice water
fresh Alka Seltzer tablets

Procedure:

1. Place approximately 150 mL of hot water in a beaker.
2. Place the same amount of ice water in a second beaker.
3. Drop an Alka Seltzer tablet into each beaker.
4. Note the rate of reaction in each beaker.

Questions:

1. What generalization about rate of reactions can be drawn from this demonstration?
2. How would the rate of reaction in water at room temperature compare with that in cold water? Hot water?

Reaction:

Fresh Alka Seltzer tablets are dropped simultaneously into beakers of ice water and hot water. The one dropped in hot water fizzes and reacts much faster than the one dropped in ice water. This demonstrates how an increase in temperature increases the rate of reaction.

CHANGING THE RATE OF DISSOLVING

Materials needed:

4 glasses or beakers
sugar cubes
water
spoon

Procedure:

1. Put approximately 100 mL of water in each beaker.
2. Place one sugar cube in the first two beakers.
3. Stir the water in the first beaker with the spoon. Leave the water in the second beaker untouched.
4. Compare the rate of dissolving.
5. Use the spoon to crush the sugar cube.
6. Carefully drop the crushed sugar cube into the third beaker.
7. Place one sugar cube in the fourth beaker.
8. Compare the rate of dissolving.

Questions:

1. What effect did stirring have on the dissolving rate of the sugar cube?
2. What effect did crushing the sugar cube have on the rate of dissolving?

Reaction:

Stirring the sugar cube increases the rate of dissolving by increasing the movement of the particles. Crushing the sugar cube also increases the rate of dissolving. By decreasing the particle size the water is able to move about the particles and react faster than in the form of a cube.

HOW DOES BAKING POWDER WORK?

Materials needed:

baking powder (not baking soda)
vinegar
3 glasses or beakers
3 teaspoons
hot water
cold water
water

Procedure:

1. Fill the 3 glasses about $\frac{1}{4}$ full with water of different temperatures. Use the same type of glasses and the same amounts of water.
2. The first glass should contain cold water; the second glass should contain water at room temperature; and the third glass should contain hot water.
3. Using class helpers, place one teaspoon of baking powder into each glass. Keep stirring the solutions.
4. Note which stops bubbling first, second, and last.
5. Repeat the above procedure, but add one tablespoon of vinegar to each glass before adding the baking powder.
6. Note the reaction.

Questions:

1. What evidence indicates that you observed chemical reactions?
2. What happens to the rate of reaction when you increase the temperature?
3. What happens to the rate of reaction when you add vinegar?

Reaction:

The rate of reaction increases as the temperature increases. When vinegar is added to the water it also increases the rate of reaction.

RARE EARTH OXIDES AS CATALYSTS

Materials needed:

cigarette ashes
matches
tongs or toothpicks
sugar cubes

Procedure:

1. Show the students that you cannot burn a cube of table sugar held on a toothpick (or with tongs) with the heat from a match.
2. Take another cube, dab it in a pile of cigarette ashes; cover at least two sides of the cube. When the cube is heated with a match, the cube will burn.

Questions:

1. What is a catalyst?

Reaction:

The rare earth oxides in the cigarette ashes act as a catalyst in the combustion of sugar. A catalyst is a substance that can increase the rate of reaction without any change to its own composition.

UNIT TWO

Introduction to Atomic Structure

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Beyond the GED With Physical Science

Unit Two - INTRODUCTION TO ATOMIC STRUCTURE - Objectives

Atoms and Molecules:

1. Define an atom and a molecule.
2. Contrast the properties of atoms with the compounds formed.

The Atom's Structure:

3. Distinguish among proton, neutrons, and electrons.
4. Define atomic number, mass number, and isotopes.
5. Describe or draw Bohr's model of the atom.

The Atom in Chemical Changes:

6. Define valence electron.
7. Explain why atoms give and take electrons.
8. Contrast metal, nonmetal, metalloid, and noble gas elements.
9. Define an ion.
10. Distinguish between an ionic bond and a covalent bond.

The Periodic Table of the Elements:

11. Define a family of elements.
12. Describe how the periodic table is arranged.

The Periodic Table of the Elements:

13. Obtain information about elements and their atoms from the periodic table.
14. Locate metals and nonmentals on the periodic table.
15. Locate the inert gases on the periodic table.

INTRODUCTION TO ATOMIC STRUCTURE

Unit Two - Supply List - 6 Activities

test tube
alcohol burner
tongs
spoon
scissors
glue
sugar
matches
round balloon
ball of string
straight pin
plaster of paris
newspaper
thread
water
plastic bowl (to be thrown away)
plastic chips (different colors)
modeling clay / Play-Doh
4 small beads (2 black, 2 white)
colored markers
poster board
compass or patterns to draw circles
chart paper or chalk board
copied cutout shapes on white & shiny paper
Periodic Table of Elements

INTRODUCTION TO ATOMIC STRUCTURE

Atoms and Molecules

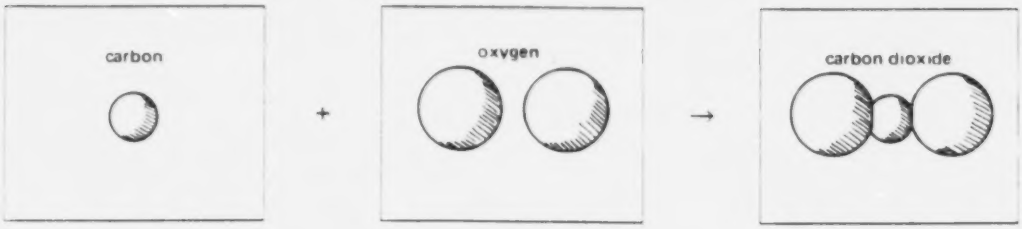
atom: smallest particle of an element that still has the chemical properties of the element.

molecule: smallest particle of a compound that still has the chemical properties of the compound. A molecule is made of atoms that are linked together.

Water is a **compound** made up of the **elements** hydrogen and oxygen. One molecule of water is made up of two hydrogen **atoms** and one oxygen **atom.**

Table salt is a **compound** made up of the **elements** sodium and chlorine. One molecule of sodium chloride is made up of one **atom** of sodium and one **atom** of chlorine.

Carbon dioxide is a **compound** made up of the **elements** carbon and oxygen. One **molecule** of carbon dioxide is made up of one **atom** of carbon and two **atoms** of oxygen.



Atoms and Molecules

Compound: substance made up of atoms joined together. The elements lose their own properties. The compound takes on new properties. Compounds do not even have to be in the same state as the elements of which they are made. A compound must have at least one metal element and one nonmetal element.

Molecule: smallest part of a compound that still has the properties of that compound. A molecule has two or more atoms linked together. Some molecules have thousands of atoms.

The examples below show how the properties of the elements are different from the properties of the compounds they form.

Element	+	**Element**	=	**Compound**
Hydrogen	+	Oxygen	=	Water
invisible gas	+	invisible gas	=	clear liquid
Sodium	+	Chlorine	=	Sodium Chloride
dangerous solid	+	deadly gas	=	safe white solid (table salt)
Carbon	+	Oxygen	=	Carbon Dioxide
dark solid	+	invisible gas	=	invisible gas

Activity: Compounds and Molecules
demonstrates that the properties of the elements are very different from the properties of the compound

COMPOUNDS AND MOLECULES

Materials needed:

sugar
test tube
alcohol burner
tongs
matches

Procedure:

1. Place a small amount of sugar in the test tube.
2. Hold with tongs and heat sugar until it melts.
3. Observe the black solid.

Questions:

1. What is left in the test tube?
2. What happened to the other elements?
3. Would like to add this black char to your cereal?

Reactions:

Sugar is a compound made up of the elements of Carbon, Hydrogen, and Oxygen. When heated the Hydrogen and Oxygen convert to a gas and evaporate leaving only Carbon. The properties of the compound, sugar, are very different from the properties of the elements that make it up.

PARTS OF AN ATOM
ELECTRON ARRANGEMENT

Electron: a part of the atom that has a negative electrical charge; orbits the nucleus.

Proton: a part of the atom that has a positive electrical charge; is found in the nucleus.

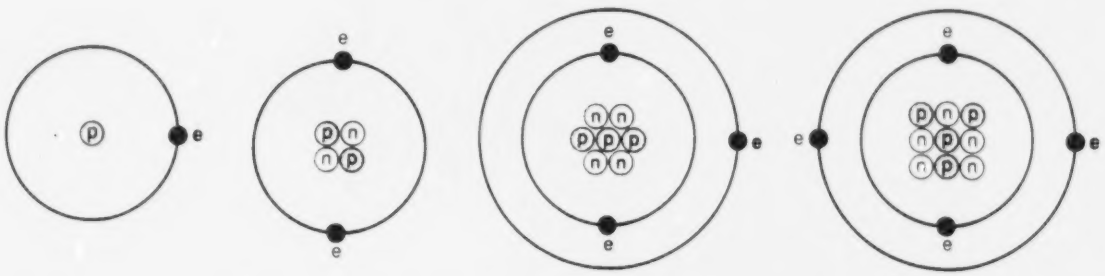
Neutron: a part of the atom that has neither a positive or a negative charge; is found in the nucleus.

Nucleus: central part of an atom, which contains neutrons and protons.

Shells: energy levels in which electrons are arranged around the nucleus.

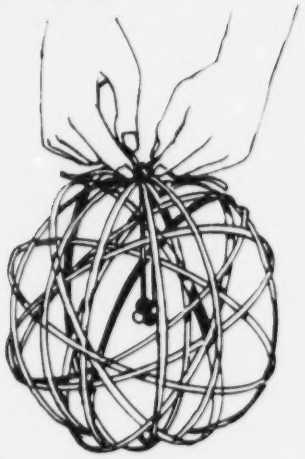
ACTIVITY: Have students work in small groups to make models of the atoms shown below. Have different color plastic chips, clay, or marbles available for the students to use.

Hydrogen	**Helium**	**Lithium**	**Beryllium**
1 proton	2 protons	3 protons	4 protons
1 electron	2 neutrons	4 neutrons	5 neutrons
	2 electrons	3 electrons	4 electrons



Activity: Making a 3-D Model of a Helium Atom

MAKING A 3-D MODEL OF A HELIUM ATOM



Materials needed:

round balloon
ball of string
½ cup of plaster of paris
½ cup of water
tablespoon
plastic bowl
straight pin
thread
4 very small beads (2 black, 2 white)
colored pen
newspaper

Procedure:

1. Blow up the balloon and tie the end.
2. Cut 10-12 pieces of string, each 2-3 feet long.
3. Spread newspaper on a table. Place about 4 tablespoons of water in a plastic bowl.
4. Gently shake 1 tablespoon of dry plaster of paris at a time into the top of the water. This will get wet and sink to the bottom of the bowl.
5. Shake another tablespoon of plaster onto the top of the water and wait for this to get wet and sink. Do this until you can see that the plaster is filling up the water. When there is only a thin layer of water on top of the plaster, it is ready to use.
6. Dip one piece of string into the plaster of paris mixture.
7. Wrap the string around the balloon several times in different directions.
8. Repeat with each string. Lay the starting end of the string over the end of the string you just finished wrapping.
9. Plaster of paris hardens very quickly, so you will have to mix several bowls of plaster before you are finished.
10. When the strings are all into place, set the balloon aside to dry overnight.
11. The next day, pop the balloon with the straight pin. This should leave you with an "electron shell" for a helium atom.
12. String the 4 beads onto a piece of thread and tie them into a small knot at the center of the thread. Tie the ends to the plaster "shell" and allow the beads to hang in the center.
13. Use the colored pen to make two very small dots at different places on the "shell". These dots are the electrons.

INTRODUCTION TO ATOMIC STRUCTURE

The Atom's Structure

Atomic Number: number assigned to each element. Equal to the number of protons in the nucleus of each atom of the element.

Atomic Mass: total number of protons and neutrons in the nucleus of each atom of the element.

Isotopes: atoms of the same element having a different mass number because they have a different number of neutrons; however, they must have the same number of protons.

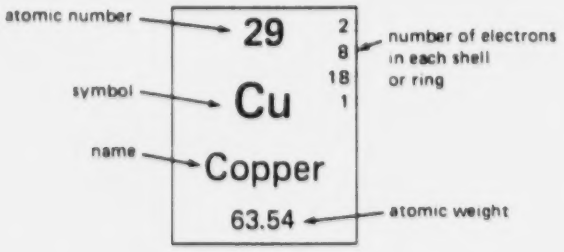
Isotopes of Common Elements - Most elements have two or more isotopes. Hydrogen, Carbon, Nitrogen, and Uranium are common elements with several isotopes.

Atomic Number = number of Protons

Atomic Mass = number of Protons + number of Neutrons

Complete the Chart: CALCULATE ATOMIC MASS

Complete the Chart: COMPARING ATOMIC NUMBER & ATOMIC MASS



INTRODUCTION TO ATOMIC STRUCTURE

The Atom's Structure

Complete the chart below.

Calculate Atomic Mass

Name of Element	Number of Protons	Number of Neutrons (rounded)	Atomic Mass
1. Oxygen	8	8	
2. Cobalt	27	32	
3. Calcium	20	20	
4. Zinc	30	35	
5. Silver	47	61	
6. Hydrogen	1	0	
7. Sulfur	16	16	
8. Uranium	92	146	
9. Potassium	19	20	
10. Iodine	53	74	
11. Lithium	3	4	
12. Neon	10	10	
13. Tungsten	74	110	
14. Krypton	36	48	

ANSWER KEY

INTRODUCTION TO ATOMIC STRUCTURE

The Atom's Structure

Complete the chart below.

Calculate Atomic Mass

Name of Element	Number of Protons	Number of Neutrons (rounded)	Atomic Mass
1. Oxygen	8	8	16
2. Cobalt	27	32	59
3. Calcium	20	20	40
4. Zinc	30	35	65
5. Silver	47	61	108
6. Hydrogen	1	0	1
7. Sulfur	16	16	32
8. Uranium	92	146	238
9. Potassium	19	20	39
10. Iodine	53	74	127
11. Lithium	3	4	7
12. Neon	10	10	20
13. Tungsten	74	110	184
14. Krypton	36	48	84

INTRODUCTION TO ATOMIC STRUCTURE

The Atom's Structure

Complete the chart below.

Comparing Atomic Number & Atomic Mass

Type of Matter	Protons	Neutrons	Atomic Mass	Electrons	Atomic Number
1. Oxygen	8		16	8	8
2. Sodium			23	11	
3. Carbon		6	12		
4. Phosphorus		16			15
5. Iron	26		56		
6. Potassium	19	20			
7. Copper	29	35	64		
8. Chlorine			35		17
9. Boron	5	6	11		
10. Aluminum		14	27		

* Note: Neutral atoms have the same number of protons as electrons.

ANSWER KEY

INTRODUCTION TO ATOMIC STRUCTURE

The Atom's Structure

Complete the chart below.

Comparing Atomic Number & Atomic Mass

Type of Matter	Protons	Neutrons	Atomic Mass	Electrons	Atomic Number
1. Oxygen	8	*8*	16	8	8
2. Sodium	*11*	*12*	23	11	*11*
3. Carbon	*6*	6	12	*6*	*6*
4. Phosphorus	*15*	16	*31*	*15*	15
5. Iron	26	*30*	56	*26*	*26*
6. Potassium	19	20	*39*	*19*	*19*
7. Copper	29	35	64	*29*	*29*
8. Chlorine	*17*	*18*	35	*17*	17
9. Boron	5	6	11	*5*	*5*
10. Aluminum	*13*	14	27	*13*	*13*

* Note: Neutral atoms have the same number of protons as electrons.

DRAW A DIAGRAM OF AN ATOM
BOHR'S MODEL

Niels Bohr stated that an atom looks like the solar system. The electrons go around the nucleus just as the planets orbit the sun. He also believed that electrons moved in fixed electron shells. Each shell is a different distance from the nucleus and surrounds the nucleus like a ball. Bohr labeled these shells with the letter **K, L, M, N, O,** and **P.** He suggested that each electron shell can only hold a certain number of electrons. Bohr concluded that electrons in orbits near the nucleus have less energy than those in orbit far from the nucleus. For this reason, the modern term for electron shell is **energy level.**

Bohr's Shell	**Energy Level**	**Energy**	**Largest Number of Electrons it Holds**
K	1	↑ Lowest	2
L	2	|	8
M	3	|	18
N	4	|	32
O	5	Highest	50
P	6	↓	72

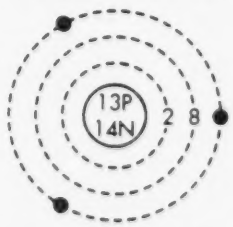
An atom diagram shows the atom's nucleus and electron shells. It includes information about **number of protons and neutrons** in the nucleus. The **electrons** are put in shells according to their **electron arrangement.**

To draw a diagram of an atom, you must know it **atomic number** and **mass number.** From these two numbers you can figure out the atom's structure using the **Bohr's model.** Below is an example of the atom Aluminum.

Atomic number = 13
Mass number = 27

Electron Arrangement = 2-8-3

Protons = 13
Neutrons = 14
Electrons = 13

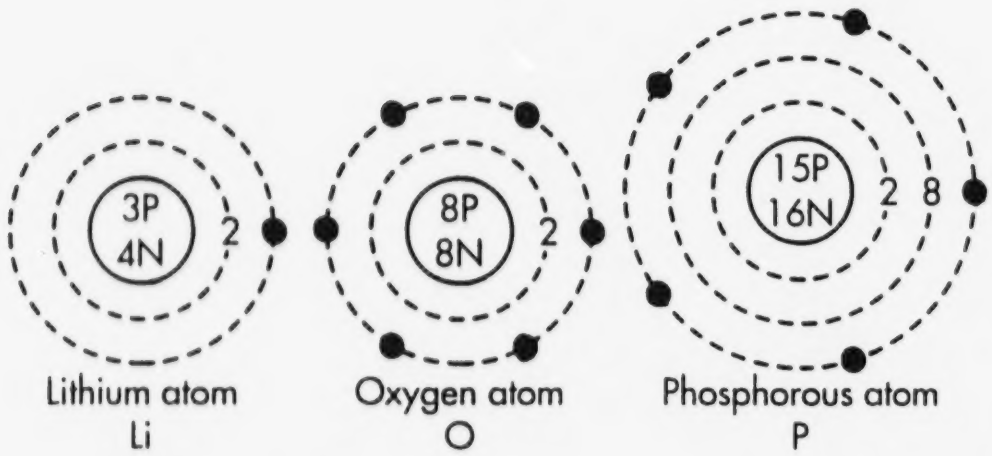


Aluminum, Al (2-8-3)

INTRODUCTION TO ATOMIC STRUCTURE

The Atom's Structure

Activity: **Using Bohr's Model**
demonstrate on the board how to draw a diagram of an atom. Let students draw in their notebooks.



Element	Lithium	Oxygen	Phosphorous
Number of Electrons	3	8	15
K-L-M Electron Arrangement	2-1	2-6	2-8-5

INTRODUCTION TO ATOMIC STRUCTURE

The Atom's Structure

Complete the chart below.

Electron Arrangement

Atom	Number of Electrons	Number Electrons in Each Shell			Is Last Shell Complete?
		K	L	M	
1. Magnesium	12	2	8	2	No
2. Carbon	6				
3. Oxygen	8				
4. Helium	2				
5. Neon	10				
6. Aluminum	13				
7. Chlorine	17				
8. Phosphorus	15				
9. Argon	18				
10. Beryllium	4				

* This chart is also used in the lesson "classifying elements."

ANSWER KEY

INTRODUCTION TO ATOMIC STRUCTURE

The Atom's Structure

Complete the chart below.

Electron Arrangement

	Atom	Number of Electrons	Number Electrons in Each Shell			Is Last Shell Complete?
			K	L	M	
1.	Magnesium	12	2	8	2	No
2.	Carbon	6	2	4		no
3.	Oxygen	8	2	6		no
4.	Helium	2	2			yes
5.	Neon	10	2	8		yes
6.	Aluminum	13	2	8	3	no
7.	Chlorine	17	2	8	7	no
8.	Phosphorus	15	2	8	5	no
9.	Argon	18	2	8	8	no
10.	Beryllium	4	2	2		no

* This chart is also used in the lesson "classifying elements."

INTRODUCTION TO ATOMIC STRUCTURE

The Atom in Chemical Changes

Completed Outer Shells: most atoms want to have two or eight electrons in their outer shells; if the K shell has two electrons and there are no electrons in other shells, we say the outer shell is complete. Any other outer shell is complete if it has eight electrons in it. Note that the M, N, O, and P shells are complete with eight electrons even though they can hold more. If an atom does not have a completed outer shell, it will give, take, or share electrons until it does. An atom has less energy with a completed outer shell. With less energy, the atom becomes more stable, meaning that it resists chemical changes.

Inert Gases / Noble Gases: elements with completed outer shells; seldom react with other elements to form compounds; "inert" means "not active" - "noble" refers to "elements staying apart from other element".

Valence Electrons: electrons in the outer most shell of an atom; determine the chemical behavior of an atom.

INTRODUCTION TO ATOMIC STRUCTURE

The Atom in Chemical Changes

Elements are classified according to their valence electrons.

Metals: elements with conduct electricity and have other properties in common; **metals give away electrons** to form positive ions; metals have **fewer than 4 outer shell electrons.**

Nonmetals: elements which do not conduct electricity and have other properties in common; **nonmetals take in electrons** to form negative ions; nonmetals have **more than 4 outer shell electrons.**

Inert or Noble Gases: completed outermost shell.

Metalloids: elements which have properties between those of metals and nonmetals.

Activity: Classify the Elements.

Use the 10 elements on the completed chart, "Electron Arrangement" to classify the elements as Metals, Nonmetal, Inert Gases.

Metals:	**Nonmetals:**	**Inert Gases:**
Magnesium	Carbon	Helium
Aluminum	Oxygen	Neon
Beryllium	Chlorine	Argon
	Phosphorus	

INTRODUCTION TO ATOMIC STRUCTURE

The Atom in Chemical Changes

Ion: atom with an electric charge due to electrons gained or lost.

Ionic Bond: chemical bond formed by the transfer of electrons from one atom to another, creating oppositely charged ions which attract each other.

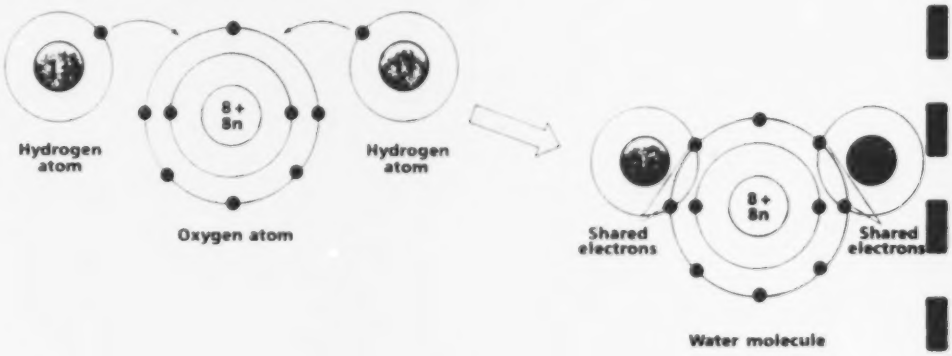
Covalent Bond: chemical bond formed between atoms by the sharing of electrons.

Activity: Use Bohr's model to illustrate the atoms of an ionic bond and a covalent bond. Students can make a poster to show the two types of bonding. Students can draw and/or use plastic chips of different colors.

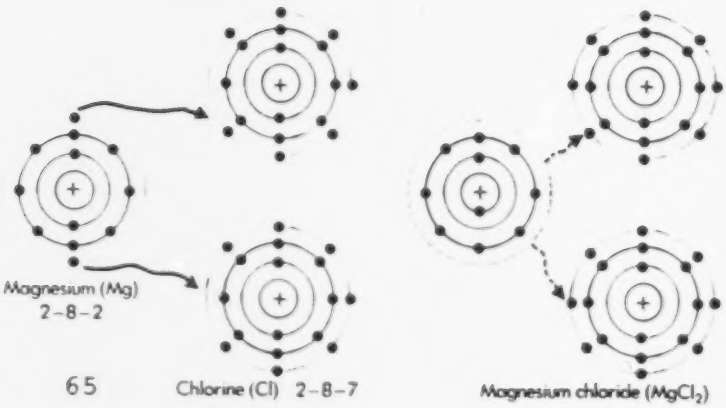
Materials needed:

- poster board
- markers
- compass or patterns to draw circles
- plastic chips
- glue

COVALENT BOND



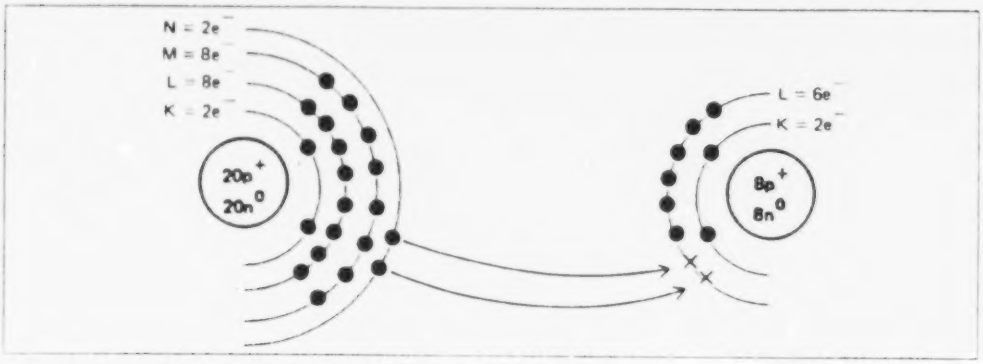
IONIC BOND

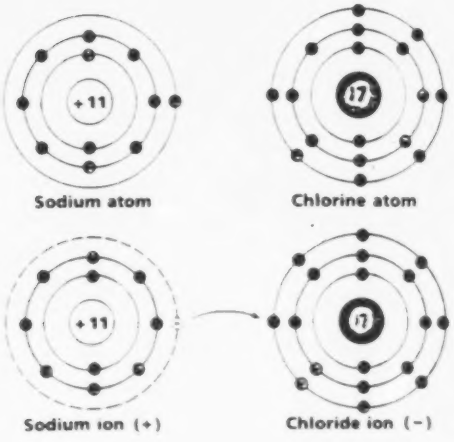


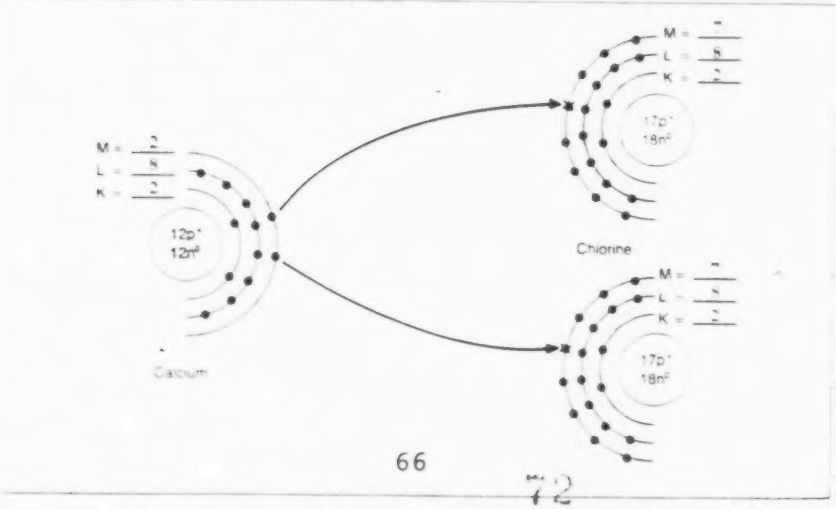
One atom of magnesium lends two electrons to two atoms of chlorine, forming one molecule of magnesium chloride ($MgCl_2$).

IONIC BONDING

Calcium and oxygen join to form the compound calcium oxide (CaO).







INTRODUCTION TO ATOMIC STRUCTURE

The Periodic Table of the Elements

Activity: **Grouping Cutouts By One Properties At A Time**
introduction to arrangement of Periodic Table
by grouping items with similar properties.

Group: each **column** on the table is a **family** of elements. Elements in the groups have the same number of electrons in their outermost shell. Elements in a family have similar chemical and physical properties. The periodic table contains 18 groups.

Period: each **row** of elements have the same outer electron shell, such as K, L, or M. The periodic table contains 7 periods. Elements within a period are about the same size.

Arrangement by Atomic Number: elements are arranged by increasing atomic number read from left to right.

Metals are on the left side of the table.

Nonmetals are on the right side of the table.

Hydrogen is in two places in the periodic table because it can act as a metal or nonmetal.

Complete the Chart. USING THE PERIODIC TABLE

GROUPING CUTOUTS BY ONE PROPERTY AT A TIME

Materials needed:

scissors
cutouts on white paper
cutouts copied on shiny paper
Table of Cutouts

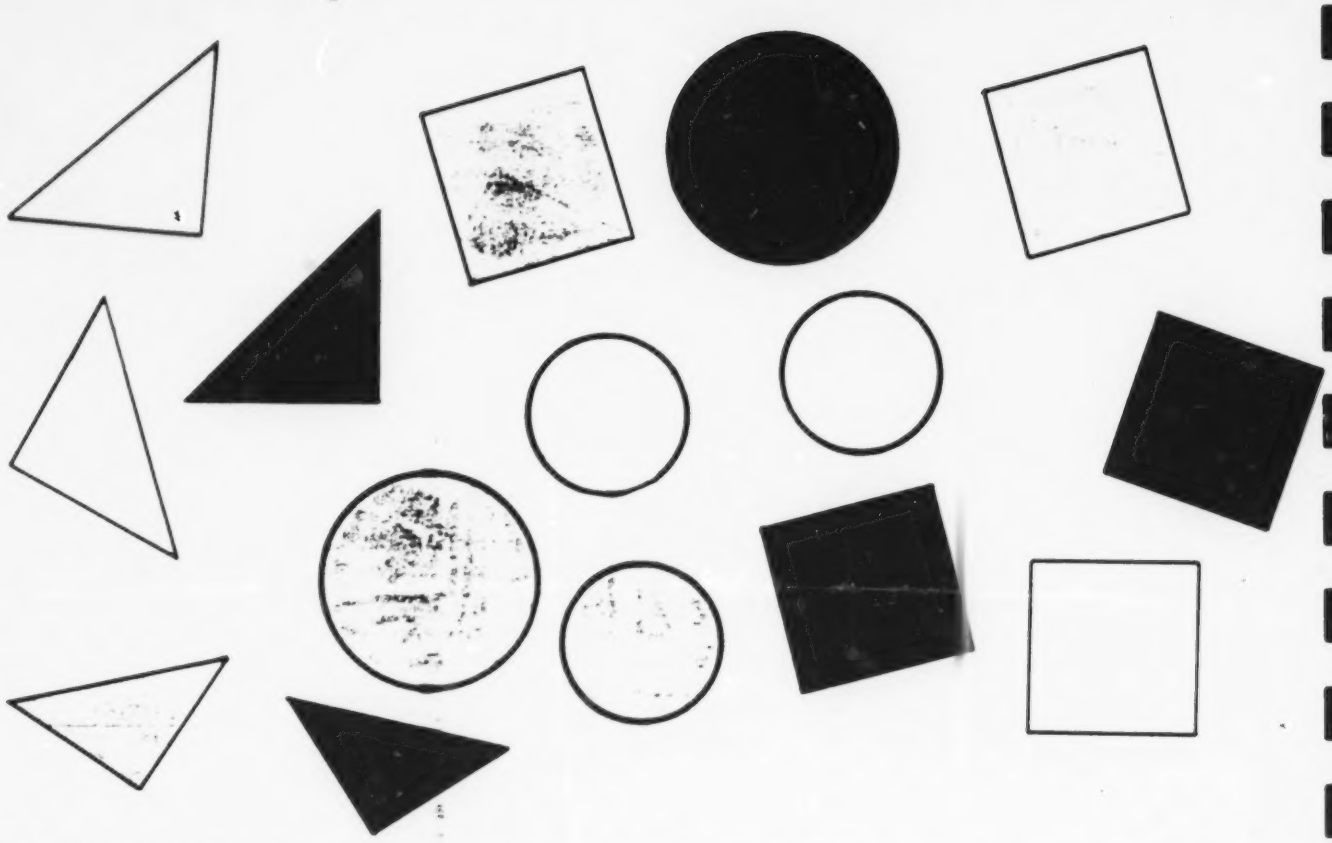
Procedure:

1. Cut out all shapes.
2. Group the cutouts by observing their properties. For each of the properties below, divide the cutouts into groups.

   Hardness, Shine, Color, Shape
3. Students will realize that cutouts can belong to more than one group.
4. Use the "Table of Cutouts" to organize the properties of the cutouts.

Reaction:

Elements are grouped by their properties. Some of the main properties of elements are hardness, color, shine, and size. The Periodic Table of Elements groups elements by properties. Large, heavy elements are toward the bottom of the Table. Light, small elements are toward the top of the table. Metals are on the left part and non-metals are on the right part of the Table.



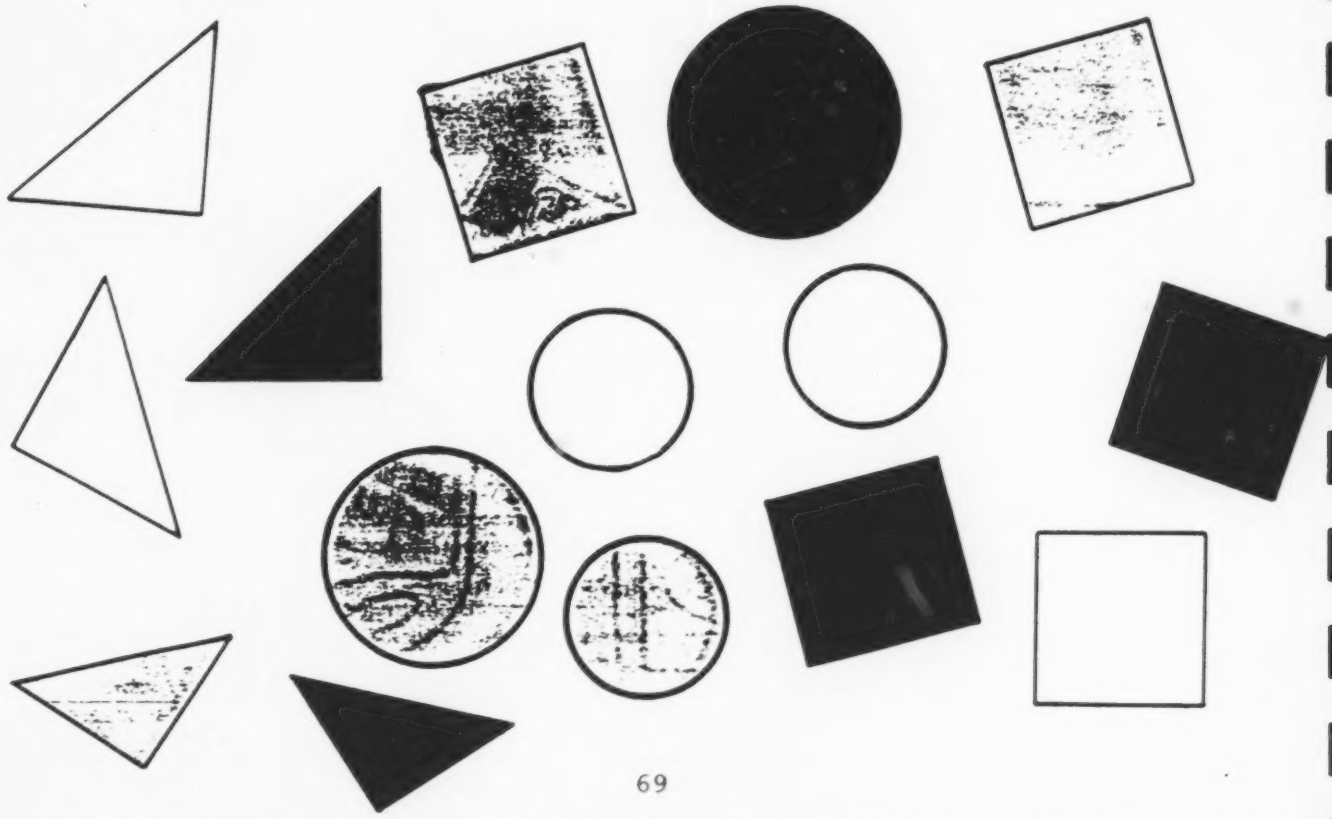


Table of Cutouts

Soft/Dull Paper			Hard/Shiny Paper		
white _____	white _____	white _____	white _____	white _____	white _____
			grey _____	grey _____	grey _____
grey _____	grey _____	grey _____	blue _____	blue _____	blue _____
			red _____	red _____	red _____
black _____	black _____	black _____	black _____	black _____	black _____

INTRODUCTION TO ATOMIC STRUCTURE

The Periodic Table of the Elements

Complete the chart below.

Using the Periodic Table

Period (row)	**Group** (column)	**Element**	**Symbol**	**Atomic Number**
2	16			
3	1			
4	8			
1	18			
6	12			
		Chlorine		
		Potassium		
		Neon		
		Tin		
		Krypton		

ANSWER KEY

INTRODUCTION TO ATOMIC STRUCTURE

The Periodic Table of the Elements

Complete the chart below.

Using the Periodic Table

Period (row)	Group (column)	Element	Symbol	Atomic Number
2	16	Sulfur	S	16
3	1	Sodium	Na	11
4	8	Iron	Fe	26
1	18	Helium	He	2
6	12	Mercury	Hg	80
2	17	Chlorine	Cl	17
4	1	Potassium	K	19
2	18	Neon	Ne	10
5	14	Tin	Sn	50
4	18	Krypton	Kr	36

Periodic Table of The Elements

In the periodic table the elements are arranged in order of increasing atomic number. Vertical columns headed by Arabic numerals are called *Groups*. A horizontal sequence of elements is called a *Period*. The most active elements are at the top right and bottom left of the table. The staggered line (Groups 13-17) roughly separates metallic from non-metallic elements.

Groups—Elements within a group have similar properties and contain the same number of electrons in their outside energy shell.

—The first group (1) includes hydrogen and the alkali metals.

—The last (18) contains the *inert gases*.

—Group 17 includes the *halogens*.

—The elements intervening between groups 2 and 13 are called *transition elements*.

—Short vertical columns without Arabic numeral headings are called subgroups.

Periods—in a given period the properties of the elements gradually pass from a strong metallic to a strong non-metallic nature, with the last number of a period being an inert gas.

LIGHT METALS

NON METALS

1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18
Hydrogen 1.0080 **H** 1																	Helium 4.003 **He** 2
Lithium 6.939 **Li** 3	Beryllium 9.012 **Be** 4											Boron 10.811 **B** 5	Carbon 12.01115 **C** 6	Nitrogen 14.007 **N** 7	Oxygen 15.999 **O** 8	Fluorine 18.998 **F** 9	Neon 20.183 **Ne** 10
Sodium 22.990 **Na** 11	Magnesium 24.312 **Mg** 12											Aluminum 26.981 **Al** 13	Silicon 28.086 **Si** 14	Phosphorus 30.974 **P** 15	Sulfur 32.064 **S** 16	Chlorine 35.453 **Cl** 17	Argon 39.948 **Ar** 18
Potassium 39.102 **K** 19	Calcium 40.08 **Ca** 20	Scandium 44.956 **Sc** 21	Titanium 47.90 **Ti** 22	Vanadium 50.942 **V** 23	Chromium 51.996 **Cr** 24	Manganese 54.938 **Mn** 25	Iron 55.847 **Fe** 26	Cobalt 58.933 **Co** 27	Nickel 58.71 **Ni** 28	Copper 63.54 **Cu** 29	Zinc 65.37 **Zn** 30	Gallium 69.72 **Ga** 31	Germanium 72.59 **Ge** 32	Arsenic 74.922 **As** 33	Selenium 78.96 **Se** 34	Bromine 79.909 **Br** 35	Krypton 83.80 **Kr** 36
Rubidium 85.47 **Rb** 37	Strontium 87.62 **Sr** 38	Yttrium 88.905 **Y** 39	Zirconium 91.22 **Zr** 40	Niobium 92.906 **Nb** 41	Molybdenum 95.94 **Mo** 42	Technetium (99) **Tc** 43	Ruthenium 101.07 **Ru** 44	Rhodium 102.91 **Rh** 45	Palladium 106.4 **Pd** 46	Silver 107.87 **Ag** 47	Cadmium 112.40 **Cd** 48	Indium 114.82 **In** 49	Tin 118.69 **Sn** 50	Antimony 121.75 **Sb** 51	Tellurium 127.60 **Te** 52	Iodine 126.90 **I** 53	Xenon 131.30 **Xe** 54
Cesium 132.90 **Cs** 55	Barium 137.34 **Ba** 56	Lanthanum 138.91 **La** 57	Hafnium 178.49 **Hf** 72	Tantalum 180.95 **Ta** 73	Tungsten 183.85 **W** 74	Rhenium 186.21 **Re** 75	Osmium 190.2 **Os** 76	Iridium 192.2 **Ir** 77	Platinum 195.09 **Pt** 78	Gold 196.97 **Au** 79	Mercury 200.59 **Hg** 80	Thallium 204.37 **Tl** 81	Lead 207.19 **Pb** 82	Bismuth 208.98 **Bi** 83	Polonium (210) **Po** 84	Astatine (210) **At** 85	Radon (222) **Rn** 86
Francium 223 **Fr** 87	Radium (226) **Ra** 88	Actinium 227 **Ac** 89	Unniquadium 261 **Unq** 104	Unnipentium 262 **Unp** 105	Unnihexium 263 **Unh** 106	**Uns** 107	**Uno** 108	**Une** 109	110	111	112	113	114	115	116	117	118

Cerium 140.12 **Ce** 58	Praseodymium 140.91 **Pr** 59	Neodymium 144.24 **Nd** 60	Promethium (147) **Pm** 61	Samarium 150.35 **Sm** 62	Europium 151.96 **Eu** 63	Gadolinium 157.25 **Gd** 64	Terbium 158.92 **Tb** 65	Dysprosium 162.50 **Dy** 66	Holmium 164.93 **Ho** 67	Erbium 167.26 **Er** 68	Thulium 168.93 **Tm** 69	Ytterbium 173.04 **Yb** 70	Lutetium 174.97 **Lu** 71
Thorium 232.04 **Th** 90	Protactinium (231) **Pa** 91	Uranium 238.03 **U** 92	Neptunium (237) **Np** 93	Plutonium (242) **Pu** 94	Americium (243) **Am** 95	Curium (247) **Cm** 96	Berkelium (249) **Bk** 97	Californium (251) **Cf** 98	Einsteinium (254) **Es** 99	Fermium (253) **Fm** 100	Mendelevium (256) **Md** 101	Nobelium (254) **No** 102	Lawrencium (260) **Lr** 103

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chemistry

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UNIT THREE

Chemical Formulas and Equations

Beyond the GED With Physical Science

Unit Three - CHEMICAL FORMULAS & EQUATIONS - Objectives

Writing Chemical Formulas:

1. Identify element symbols.
2. Explain a chemical formula.
3. Distinguish a subscript from a coefficient.

Writing Chemical Equations:

4. Interpret the information contained in a chemical equation.
5. Balance equations.
6. Explain diatomic molecules.

CHEMICAL FORMULAS AND EQUATIONS

Unit Three - Supply List - 2 Activities

Periodic Table of Elements
index cards
markers

CHEMICAL FORMULAS AND EQUATIONS

Writing Chemical Formulas

Rules for Writing Element Symbols:

1. The symbols always begin with a capital letter.
2. If there is a second letter, it is a lower case letter.
3. No period is used at the end of the symbol.

There are 109 elements: 92 known elements are found in nature
17 elements have been made by scientists in the laboratory

The symbols for the elements are the same all over the world. It makes no difference what language you speak. The language of Chemistry is Universal.

How do the elements get their symbols?

The symbol for an element is taken from its **name.** Often the first letter of an element's name is the symbol.

Element	Symbol
Oxygen	O
Carbon	C
Nitrogen	N
Hydrogen	H

The name of an element may begin with a letter that is already the symbol for another element. In this case we use either the first two letters or the first letter and some other letter from the name.

Element	Symbol
Osmium	Os
Chlorine	Cl
Calcium	Ca
Helium	He
Aluminum	Al
Nickel	Ni

Activity: **Reviewing the Symbols for the Elements**
Make flash cards for the symbols following the rules and guidelines - Symbol on one side, Name on the other side. Have students review with a partner or as a group.

CHEMICAL FORMULAS AND EQUATIONS

Writing Chemical Formulas

How do elements get their names?

The symbols for most elements are taken from their names in other languages - mostly Latin and Greek.

Element	Symbol	Foreign Name
Iron	Fe	Ferrum (Latin)
Lead	Pb	Plumbum (Latin)
Gold	Au	Aurium (Latin)
Barium	Ba	Barys (Greek)
Lithium	Li	Lithos (Greek)

Several elements are named after places or after famous scientists.

Elements	Symbols	Named for
Americium	AM	America
Einsteinium	Es	Einstein
Californium	Cf	California
Europium	Eu	Europe
Curium	Cm	Marie Curis, French Scientist
Fermium	Fm	Enrico Fermi, Italian Physicist

Activity: **Reviewing the Symbols for the Element**
Add to the previous group of flash cards following the rules and guidelines. Have students review with a partner or as a group.

CHEMICAL FORMULAS AND EQUATIONS

Writing Chemical Formulas

Chemical Formulas: each compound has its own chemical formula;

A Chemical Formula tells us two important things about a compound
1. what elements the compound is made of
2. how many atoms of each element are in a molecule of the compound

The formula for a compound is always the same. A change in the formula means that a new substance was formed.

Formula: HgO
Name: mercuric oxide
Elements: mercury (Hg) and oxygen (O)
Number of atoms in each element: 1 atom of mercury
1 atom of oxygen
Total number of atoms in one molecule: 2 atoms total

Formula: KCl
Name: potassium chloride
Elements: potassium (K) and chlorine (Cl)
Number of atoms in each element: 1 atom of potassium
1 atom of chlorine
Total number of atoms in one molecule: 2 atoms total

Formula: NaOH
Name: sodium hydroxide (lye)
Elements: sodium (S), oxygen (O), and hydrogen (H)
Number of atoms in each element: 1 atom of sodium
1 atom of oxygen
1 atom of hydrogen
Total number of atoms in one molecule: 3 atoms total

Formula: Fe_2O_3
Name: iron oxide (rust)
Elements: iron (Fe) and oxygen (O)
Number of atoms in each elements: 2 atoms of iron
3 atoms of oxygen
Total number of atoms in one molecule: 5 atoms total

Formula: H_2SO_4
Name: sulfuric acid
Elements: hydrogen (H), sulfur (S), and oxygen (O)
Number of atoms in each elements: 2 atoms of hydrogen
1 atom of sulfur
4 atoms of oxygen
Total number of atoms in one molecule: 7 atoms total

CHEMICAL FORMULAS AND EQUATIONS

Writing Chemical Formulas

Subscript: small number written after and slightly below the symbol for an element; tells how many atoms of an element are in a molecule.

Coefficient: a number placed in front of a formula to indicate how many molecules are being considered; in 5 Na3PO$\frac{1}{4}$ the number 5 is a coefficient; you multiply all the symbols in the formula by 5 to determine the number of atoms for each element.

$5\ Na_3PO_4$ = 5 x Na_3 = 15 Na atoms
= 5 x P = 5 P atoms
= 5 x O_4 = 20 atoms
40 atoms total

Formulas with Parentheses: some formulas contain a group of symbols inside parentheses. Example: Al(NO3)3. This means there is one atom of Al attached to three groups of NO3.

$Al(NO_3)_3$ = 1 atom Al
3 groups of NO_3 = 3 atoms of N
= 9 atoms of O
13 atoms total

Complete the Chart: ELEMENTS AND FORMULAS

CHEMICAL FORMULAS AND EQUATIONS

Writing Chemical Formulas

Complete the chart below.

Elements and Formulas

Formula & Name	Number of Elements	Names of the Elements	Number of Atoms of Each Element	Total Number of Atoms One Molecule
1. MgO magnesium oxide				
2. SO_2 sulfur dioxide				
3. NH_3 ammonia				
4. H_2CO_3 carbonic acid (soda water)				
5. $C_{12}H_{22}O_{11}$ table sugar				
6. $MgSO_4$ Epsom salts				
7. H_2O_2 hydrogen peroxide				
8. $NaHCO_3$ sodium bicarbonate (baking soda)				

SS

ANSWER KEY

CHEMICAL FORMULAS AND EQUATIONS

Writing Chemical Formulas

Complete the chart below.

Elements and Formulas

Formula & Name	Number of Elements	Names of the Elements	Number of Atoms of Each Element	Total Number of Atoms One Molecule
1. MgO magnesium oxide	2	Magnesium Oxygen	1 1	2
2. SO_2 sulfur dioxide	2	Sulfur Oxygen	1 2	3
3. NH_3 ammonia	2	Nitrogen Hydrogen	1 3	4
4. H_2CO_3 carbonic acid (soda water)	3	Hydrogen Carbon Oxygen	2 1 3	6
5. $C_{12}H_{22}O_{11}$ table sugar	3	Carbon Hydrogen Oxygen	12 22 11	45
6. $MgSO_4$ Epsom salts	3	Magnesium Sulfur Oxygen	1 1 4	6
7. H_2O_2 hydrogen peroxide	2	Hydrogen Oxygen	2 2	4
8. $NaHCO_3$ sodium bicarbonate (baking soda)	4	Sodium Hydrogen Carbon Oxygen	1 1 1 3	6

CHEMICAL FORMULAS AND EQUATIONS

Writing Chemical Equations

Chemical Equation: a symbolic statement that gives the formulas of the materials which go into and come out of a chemical reaction; a **chemical change** is caused by a **chemical reaction**, the "story" of this reaction is called a **chemical equation.**

A chemical equation shows two things:

1. which substance(s) we start out with, known as **reactants.**
2. which substance(s) we end up with, known as **products.**

Reactants: materials consumed in a chemical reaction, written on the left side of the equation of the reaction.

Products: materials made by a chemical reaction, written on the right side of the equation of the reaction.

Example: Inside your body, a sugar called glucose often joins with oxygen from your lungs. This reaction produces water, carbon dioxide gas, and energy. The chemical word equation makes this reaction clearer.

glucose + oxygen ⟶ carbon dioxide + water + energy

Usually, chemical equations do not contain words. Instead, chemical equations just use symbols.

$C_6H_{12}O_6 + 6O_2 \longrightarrow 6CO_2 + 6H_2O$ + **energy**

The symbol ⟶ means "yields" or "produces".

Other examples of chemical equations:

Mg + S ⟶ MgS where magnesium and sulfur are **reactants**
magnesium sulfide is the **product**

2Li + S ⟶ Li_2S where lithium and sulfur are **reactants**
lithium sulfide is the **product**

2Na + Cl_2 ⟶ 2NaCl where sodium and chlorine are **reactants**
sodium chloride is the **product**

CHEMICAL FORMULAS AND EQUATIONS

Writing Chemcial Equations

Balanced Equation: chemical equation with the same number of each kind of atom on both sides; a description of a reaction that obeys the Law of Conservation of Matter so that the kind and number of atoms on both sides of the equation is equal.

Diatomic Molecules: molecules with two identical atoms; most gas elements exists as diatomic molecules except for the noble gases. Elements that exist as diatomic moelecules are:

H_2, N_2, O_2, F_2, Cl_2, Br_2, I_2

Examples of balanced equation with diatomic molecules:

$4Na + O_2 \longrightarrow 2Na_2O$

$2Mg + O_2 \longrightarrow 2MgO$

$4Al + O_2 \longrightarrow 2Al_2O$

$2H_2 + O_2 \longrightarrow 2H_2O$

Complete the chart: BALANCED OR UNBALANCED

Complete the chart: BALANCING AN EQUATION ON YOUR OWN

CHEMICAL FORMULAS AND EQUATIONS

Writing Chemical Equations

Complete the chart below.

Balanced or Unbalanced

Ten equations are listed below. Some are balanced and some are unbalanced. Make an "X" in the correct box next to each equation.

	Equation	Balanced	Unbalanced
1.	$Fe + S \rightarrow FeS$		
2.	$Mg + O_2 \rightarrow MgO$		
3.	$C + O_2 \rightarrow CO_2$		
4.	$P_4 + O_2 \rightarrow P_4O_{10}$		
5.	$H_2 + O_2 \rightarrow H_2O$		
6.	$Na + O_2 \rightarrow NaO_2$		
7.	$CuO + H_2 \rightarrow Cu + H_2O$		
8.	$Cu + S \rightarrow Cu_2S$		
9.	$Zn + 2HCl \rightarrow ZnCl_2 + H_2$		
10.	$2Na + H_2O \rightarrow 2NaOH + H_2$		

ANSWER KEY

CHEMICAL FORMULAS AND EQUATIONS

Writing Chemical Equations

Complete the chart below.

Balanced or Unbalanced

Ten equations are listed below. Some are balanced and some are unbalanced. Make an "X" in the correct box next to each equation.

	Equation	Balanced	Unbalanced
1.	$Fe + S \rightarrow FeS$	X	
2.	$Mg + O_2 \rightarrow MgO$		X
3.	$C + O_2 \rightarrow CO_2$	X	
4.	$P_4 + O_2 \rightarrow P_4O_{10}$		X
5.	$H_2 + O_2 \rightarrow H_2O$		X
6.	$Na + O_2 \rightarrow NaO_2$	X	
7.	$CuO + H_2 \rightarrow Cu + H_2O$	X	
8.	$Cu + S \rightarrow Cu_2S$		X
9.	$Zn + 2HCl \rightarrow ZnCl_2 + H_2$	X	
10.	$2Na + H_2O \rightarrow 2NaOH + H_2$		X

CHEMICAL FORMULAS AND EQUATIONS

Writing Chemical Equations

Complete the chart below.

Balancing An Equation On Your Own

H_2	+	F_2	→	HF			
H_2	+	S	→	H_2S			
H_2	+	N_2	→	NH_3			
Li	+	N_2	→	Li_3N			
Al	+	Br_2	→	$AlBr_3$			
NH_4OH	+	HCl	→	H_2O	+	NH_4Cl	
P_4	+	O_2	→	P_4O_{10}			
Li	+	Fl_2	→	LiFl			
Cu	+	S	→	Cu_2S			
Na	+	H_2O	→	2NaOH	+	H_2	
Ca	+	O_2	→	CaO			
H_2	+	O_2	→	H_2O			

ANSWER KEY

CHEMICAL FORMULAS AND EQUATIONS

Writing Chemical Equations

Complete the chart below.

Balancing An Equation On Your Own

H_2	+	F_2	→	2	HF			
H_2	+	S	→		H_2S			
3 H_2	+	N_2	→	2	NH_3			
6 Li	+	N_2	→	2	Li_3N			
2 Al	+	3 Br_2	→	2	$AlBr_3$			
NH_4OH	+	HCl	→		H_2O	+	NH_4Cl	
P_4	+	5 O_2	→		P_4O_{10}			
2 Li	+	Fl_2	→	2	LiFl			
2 Cu	+	S	→		Cu_2S			
2 Na	+	2 H_2O	→		2NaOH	+	H_2	
Ca	+	O_2	→	2	CaO			
2 H_2	+	O_2	→	2	H_2O			

UNIT FOUR

Common Chemicals

Beyond the GED With Physical Science

Unit Four - COMMON CHEMICALS - Objectives

Acids and Bases:

1. List the characteristics of acids and bases.
2. Describe how indicators are used to identify acids and bases.
3. Explain why some acids and bases are strong and others are weak.
4. Outline the pH scale.
5. Define the neutralization reaction.

Solutions:

6. Describe the characteristics of a solution.
7. Identify the parts of a solution.
8. Define solubility.
9. Distinguish between saturated, unsaturated and supersaturated solutions.
10. List the factors that affect the solubility of a material and the rate at which it dissolves.
11. Explain osmosis and diffusion.
12. Define semipermeable membrane.

Density:

13. Define density.
14. Explain how to find the density of a solid or liquid.
15. Define displacement.

COMMON CHEMICALS

Unit Four - Supply List - 16 Activities

markers
poster board
vinegar
detergent
water
baking soda
tall cylinder
2 beakers
large beaker or glass jar
spaghetti
hydrogen peroxide
raw potato
knife
fresh red cabbage
cooking pan with lid
heat source, electric burner
clear household ammonia
clear corn syrup
liquid soap
juice from jar of dill pickles
club soda
lemon juice
measuring spoons
measuring cup
11 clear glasses or jars
distilled water
tap water
masking tape
Phenolphthalein indicator solution
table sugar
pencil
string
paper clip
spoon
metal jar lid
soil
copper wire
table salt
blotting paper
shallow bowl
laundry bluing
food coloring
scissors
raw eggs
plastic wrap
cigarette lighter fluid
flask
matches
vegetable oil
glycerine
several small rocks
golf ball
balance
ethanol
ice cubes
can of soft drink
can of diet soft drink
watch glass
large container
1-L clear plastic bottle
rubbing alcohol
paint thinner
duct tape

COMMON CHEMICALS

Acids and Bases

Introduction - Do you eat oranges or grapefruits? Do you use vinegar on salads? If so, you have been eating common chemicals. Your digestion of food depends on other chemicals that are made in you stomach. Although many common chemicals are important in nutrition, some common chemicals can be very dangerous. For example, car batteries contain strong chemicals that are very corrosive. Even too much salt on your food can be unhealthy.

All things are made of chemicals. Your body creates chemicals regularly. We are going to study the chemistry of some "old friend", the chemicals you use regularly.

Two of the most common compounds are acids and bases.

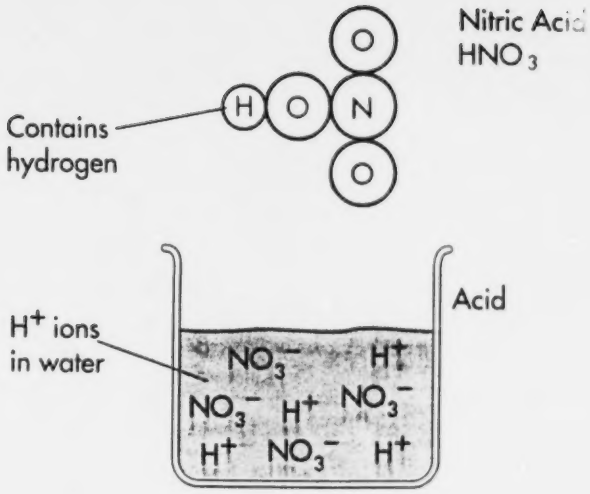
Acids: all acids contain hydrogen and release hydrogen ions when dissolved in water. A compounds that contains hydrogen is not necessarily an acid. Acids are corrosive. This means they can dissolve other materials such as cement, bones, teeth, rocks, and metal surfaces.

Common Acids include:

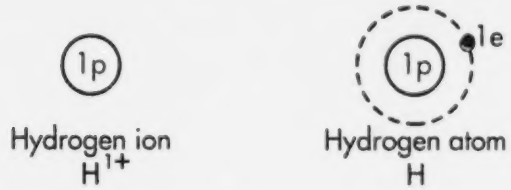
H_2CO_3	Carbonic Acid found in soda water & seltzer.
$H_3C_6H_5O_7$	Citric Acid found in citrus fruits.
$HC_2H_3O_2$	Acetic Acid found in vinegar.

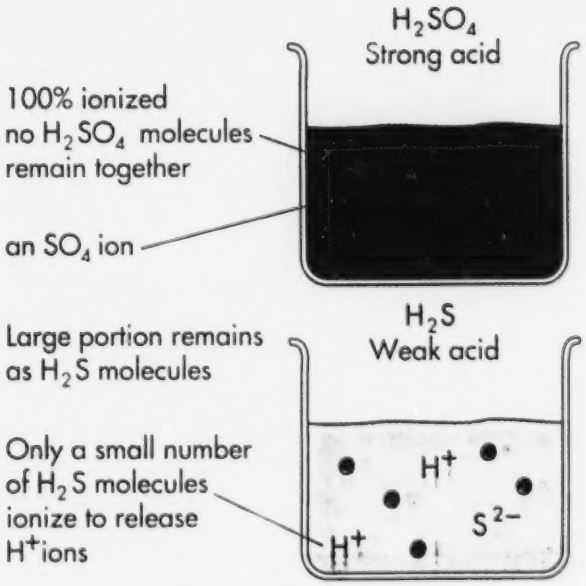
Acid Strength: is determined by how well the acid ionizes in water. That is, how many hydrogen ions are released in water. A strong acid ionizes 100% so that all of the hydrogen atoms come off in the water to form hydrogen ions. A weak acid only releases a small fraction of hydrogen atoms and reacts very slowly with other materials.

Activity: Have students make their own drawings to illustrate Acids. Use the next page as an example.



Acids release H^+ ions in water.





COMMON CHEMICALS

Acids and Bases

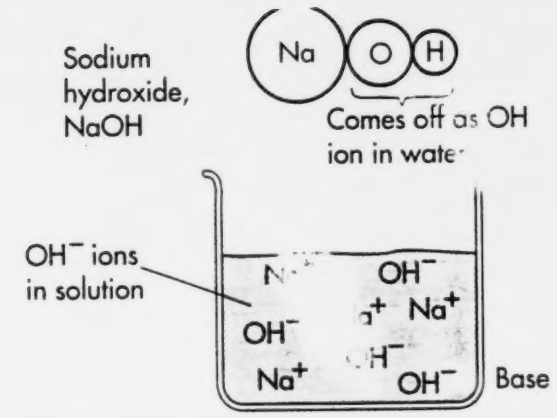
Bases: is any compound that releases hydroxide ions in water. All bases contain hydroxide ions, OH^-, with a single negative charge, or -1. Not all compounds with OH^- are bases. To be a base the OH^- must have a weak bond with the molecule in order to be released in water. Bases are corrosive and can harm your clothing and skin.

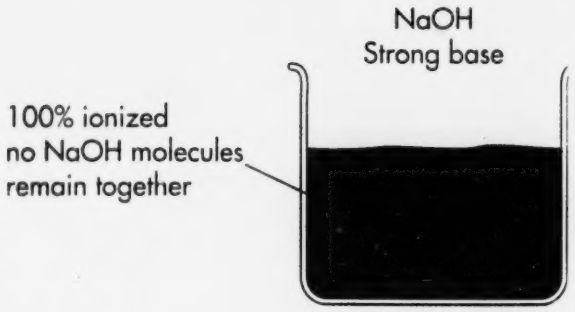
Common Bases include:

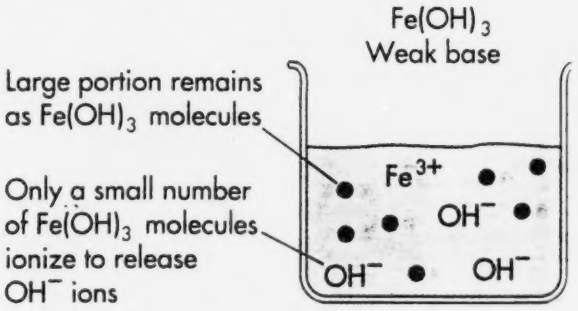
NaOH	Sodium hydroxide, lye, used to make soap and clean clogged pipes.
NH_4OH	Ammonium hydroxide, ammonia water, used for cleaning.
$Mg(OH)_2$	Magnesium hydroxide, milk of magnesia, used when you have an upset stomach.

Base Strength: is determined by how well it ionizes in water. A strong base relases large amounts of OH ions. A weak base releases a small amount of OH ions. A strong base is often called an **alkalis.**

Activity: Have students make their own drawings to illustrate a Base. Use the examples from the next page.


Sodium hydroxide, NaOH
Na
O
H
Comes off as OH ion in water
OH⁻ ions in solution
OH⁻
Na⁺
OH⁻
Base


NaOH
Strong base
100% ionized
no NaOH molecules
remain together


Fe(OH)3
Weak base
Large portion remains as Fe(OH)3 molecules
Only a small number of Fe(OH)3 molecules ionize to release OH⁻ ions
Fe3+
OH⁻
OH⁻
OH⁻

A SIMPLE REACTION TO PRODUCE FOAM

Materials needed:

vinegar
detergent
water
baking soda
tall cylinder
beaker

Procedure:

1. Prepare solution A (vinegar and detergent) by placing about 1 Tbs of laundry detergent in 50 mL of white vinegar (acetic acid).
2. Prepare solution B (water and baking soda) by dissolving about 1 Tbs of baking soda (sodium bicarbonate) in 50 mL of water.
3. Place solution A in a large beaker.
4. Place solution B in a tall cylinder.
5. Pour solution A from the beaker into solution B in the tall cylinder.
6. Observe.

Questions:

1. What is the foam made of? (CO_2 trapped in detergent bubbles.)
2. Can you suggest other ways that CO_2 could be trapped? (egg whites)

Reaction:

This foam is produced by the production of carbon dioxide gas in a detergent solution when acetic acid (HCH_3COO) in vinegar reacts with baking soda ($NaHCO_3$).

$$H^+(aq) + HCO_3^-(aq) \longrightarrow CO_2(g) + H_2O(l)$$

DANCING SPAGHETTI

Materials needed:

large beaker or quart jar
water
2 Tbs. baking soda ($NaHCO_3$)
spaghetti
vinegar

Procedure:

1. Almost fill a large beaker or quart jar with water.
2. Place 2 Tbs of baking soda in solution.
3. Add a handful of broken spaghetti.
4. Slowly add up to 100 mL of vinegar until the spaghetti begins to "dance".

Questions:

1. What kind of spaghetti movement did you observe?
2. Describe the difference between the rising piece of spaghetti and a falling piece of spaghetti?

Reaction:

Acetic acid in vinegar reacts with baking soda to produce a carbon dioxide gas.

$$H^+(aq) + HCO_3^-(aq) \longrightarrow H_2O(l) + CO_2(g)$$

When the bubbles of CO_2 attach to the spaghetti, the spaghetti is carried to the surface as the bubbles rise. When the CO_2 escapes at the surface, the spaghetti falls.

This demonstration could be done with spaghetti and a glass of soda pop or drop a few raisins in a glass of clear carbonated soda. Even the raisins have their ups and downs.

BREAKING DOWN HYDROGEN PEROXIDE

Materials needed:

beaker or glass container
hydrogen peroxide
raw potato
knife

Procedure:

1. Carefully cut a slice from the center of the potato about 0.5 cm thick.
2. Pour hydrogen peroxide into the beaker up to the 75-mL mark.
3. Place the potato slice into the beaker.
4. Observe.

Questions:

1. What happened when the potato was put into the hydrogen peroxide?
2. What do you think caused this result?

Reaction:

Hydrogen peroxide is a compound made up of the elements hydrogen and oxygen.

COMMON CHEMICALS

Acids and Bases

Indicators: chemicals which change color to show if a solution is acid or basic; some show approximate pH.

Indicator phenolphthlein is colorless if acid; reddish-pink if a base.

Litmus is a red indicator is acids; blue in bases; usually put into paper strips called litmus paper.

Methyl Orange is an indicator that is red in acids and yellow is bases.

Universal indicators use various colors to show the strength of an acid or base.

pH: measurement of how acidic or basic a solution is; 0 is strongly acid, 7 is neutral, 14 is strongly basic.

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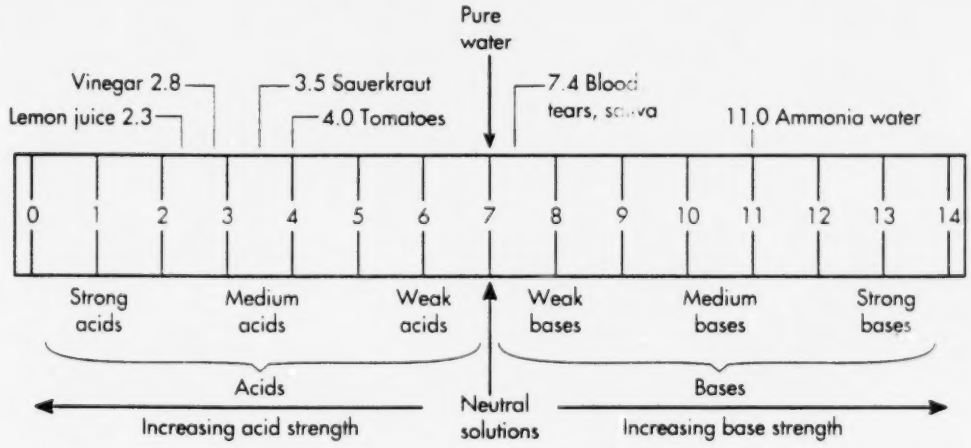
pH Scale, from 0 to 14



Activity: **Making an Indicator**
demonstrates color testing for acids and bases with a red cabbage juice indicator

Activity: Have students draw a pH scale using the results of the previous activity.

MAKING AN INDICATOR

Materials needed to make cabbage juice:

1 cup chopped, fresh red cabbage
1 cup of water
cooking pan with lid
heat source, stove

Materials needed to test for acid/base properties:

cabbage juice
white vinegar
clear household ammonia
clear corn syrup
baking soda
few drops of liquid soap
juice from jar of dill pickles
club soda
lemon juice
measuring spoons
measuring cup
11 clear glasses or jars
distilled water
tap water
tape

Procedure to make cabbage juice:

1. measure a cup of water and pour into cooking pan.
2. Put one cup of red cabbage in the pan. Put the lid on the pan and turn on the heat.
3. Boil the cabbage for 15 minutes over medium heat. The water should turn dark red/purple.
4. Turn off the heat. Pour off the cabbage juice in to a class or beaker. May want to use a strainer.
5. Let red cabbage juice indicator cool.

Procedure to test for acid/base properties:

1. Write each of the following names on a piece of tape and label each glass.

Baking Soda	Corn Syrup
Lemon Juice	Tap Water
Vinegar	Distilled Water
Pickle Juice	Club Soda
Liquid Soap	Household Ammonia

Making an Indicator
(Continued)

2. Prepare each liquid for its test by measuring the following into each glass.

   1 Tbs. distilled water
   1 Tbs. tap water
   ¼ tsp. baking soda in 1 Tbs. distilled water
   ½ tsp. lemon juice
   ½ tsp. vinegar
   ½ tsp. dill pickle juice
   few drops of liquid soap in 1 Tbs. distilled water
   ½ tsp. corn syrup in 1 Tbs. distilled water
   ½ tsp. plain club soda
   ½ tsp. ammonia

3. Measure and add ¼ to ½ teaspoon of cabbage juice into the distilled water glass. Observe and record your observation.
4. Repeat with each substance.

Questions:

1. What color did the indicator turn each sample?

Reaction:

The liquids that are neither acid nor base show no change of color. They show the color of the cabbage juice. Acids turn pink. Bases turn blue or green.

Acids - pink, purplish pink, or slightly pink
Neutral - same color os cabbage juice, almost clear
Bases - light blue, blue green, or green

COMMON CHEMICALS

Acids and Bases

Neutralization: reaction of an acid and a base to form a salt and water. Neutralization is an ionic exchange reaction that occurs when the H^+ ion of acids joins with the OH^- ion of bases. The electrical charges cancel each other out so the product is electrically neutral.

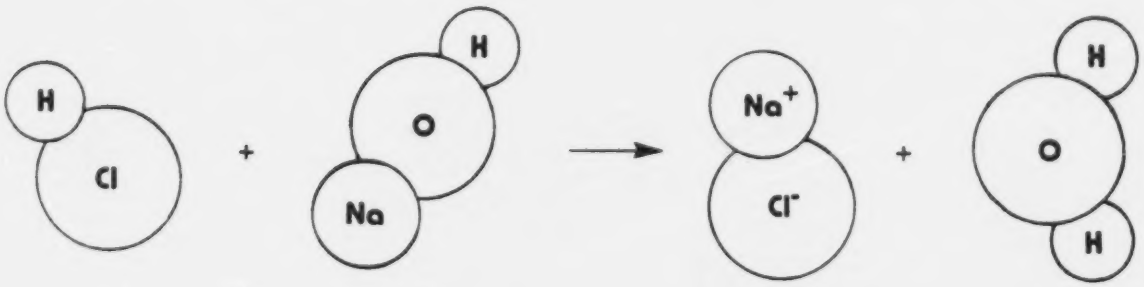
Example:

$$\mathbf{HCl} + \mathbf{NaOH} \longrightarrow \mathbf{NaCl} + \mathbf{H_2O}$$

hydrochloric acid + sodium hydroxide ⟶ sodium chloride + water

The hydrogen ions in the **HCl** join with the hydroxide ions of the **NaOH** to form water. The remaining sodium and chlorine atoms combine to form sodium chloride, which is table salt.

Activity: **"Magic" Color Changes in Solutions**
demonstrates acid/base reactions and neutralization



$$HCl + NaOH \longrightarrow NaCl + H_2O$$

"MAGIC" COLOR CHANGES IN SOLUTIONS

Materials needed:

4 beakers or plastic glasses
Phenolphthalein indicator solution
Acetic Acid (Vinegar)
Household Ammonnia solution
Water

Procedure:

1. Number the beakers 1, 2, 3, and 4.
2. Put 5 drops of Phenolphthalein solution in **beaker 1.**
3. Put 5 drops of ammonia solution in **beaker 2** and 15 drops in **beaker 4.**
4. Put about 10 drops of vinegar in **beaker 3.** Now you are ready to produce "magic" colors.
5. Add about 50 mL of water to each beaker. All beaker solution should be colorlesss.
6. Note the appearance of the solution in **beaker 1.** Pour the contents from **beaker 1** into **beaker 2.** Note the reaction.
7. Pour the contents of **beaker 2** into **beaker 3.** Note the reaction.
8. Pour the contents of **beaker 3** into **beaker 4.** Note the reaction.

Questions:

1. What is an indicator?
2. Can you make the solution turn colorless again?
3. What kind of solution makes phenolphthalein turn pink?
4. Write word or chemical equations for each of the netralization reactions.

Reaction:

These are all acid-base reactions in which an indicator is used.

1. Beaker 1 poured into beaker 2: Basic ammonia (NH_3) is beaker 2 reacts with the phenolphthalein in beaker 1 to turn it from colorless to pink.
2. Beaker 2 poured in beaker 3: The acid (vinegar) neutralizes the ammonia, and then extra acid turns the indicator colorless again. When ammonia is neutralized by vinegar, the new substances that are made are water and a salt, ammonium acetate.
3. Beaker 3 poured into beaker 4: The ammonia solution again neutralizes the acid, and extra ammonia produces a basic solution, which turns the indicator pink again.

"Magic" Colors
(Continued)

Reaction 1: Change of indicator by the pressence of a base. When the indicator is colorless, its formula is **HIn.** When the indicator is pink, its formula is $\mathbf{In^-}$. **HIn** and $\mathbf{In^-}$ refer to a large molecule called phenolphthalein.

$$\underset{\text{colorless}}{HIn\ (aq)} + \underset{\text{base in excess}}{OH^-\ (aq)} \longrightarrow H_2O\ (l) + \underset{\text{pink}}{In^-\ (aq)}$$

Reaction 2:

$$\underset{\text{base}}{OH^-\ (aq)} + \underset{\text{acid in excess}}{H^+\ (aq)} \longrightarrow H_2O\ (l)$$

Reaction 3:

$$\underset{\text{acid}}{H^+\ (aq)} + \underset{\text{base in excess}}{OH^-\ (aq)} \longrightarrow H_2O\ (l)$$

COMMON CHEMICALS

Solutions

Solutions may contain different amounts of solute and solvent.

Solute: the substance that is dissolved.
Solvent: the substance in which the solute is disolved.
Universal Solvent: the most common solvent or universal solvent is water. This means water can dissolve more materials than any other liquid.

A solution is clear and looks the same throughout. A given amount of water will continue to dissolve a solute up to a certain amount. The maixmum, or largest, amount of material that a given quantity of water can dissolve is known as the material's **solubility.**

Solubility: maximum number of grams of a material which can dissolve in 100 g of water at a given temperature.

Unsaturated Solution: solution containing less than maximum amount of material that can be dissolved; able to dissolve more.

Saturated Solution: solution that cannot dissolve any more material; maximum amount already dissolved.

Supersaturated Solution: solution with more than the maximum amount of material that normally dissolves; supersatured solutions are unstable and easily release the excess material as a precipitate. Solution may be "tricked" into dissolving more than the maximum amount of material by increasing the temperature while dissolving material.

Precipitate: insoluble material which forms as a product in a reaction.

Factors that Affect Solubility: The rate of dissolving depends on the chemical makeup of the solute, the temperature of the water, the amount of stirring, and the size of the particles. Most solids dissolve faster in hot water than in cold. The opposite is true for gases. Small particles dissolve faster than larger ones.

Activity: **Growing Sugar Crystals**
demonstrates a supersaturated sugar solution.

Activity: **Making Crystals of Rock Salt**
demonstrates a supersaturated salt solution.

Activity: **The Chemistree: Absorption and Evaporation**
demonstrates crystals formed from an evaporated solution.

GROWING SUGAR CRYSTALS

(this activity will take 3-10 days)

Materials needed:

table sugar
pan to heat water & sugar
tall jar or glass
pencil
string
paper clip
heat source, burner
spoon

Procedure:

1. Heat about 250mL of water in a pan until it boils.
2. Add sugar to the water and stir. Continue to add sugar (about 2 cups) until no more sugar will dissolve.
3. Pour the hot sugar solution into a jar or glass.
4. Tie one end of string to a pencil; tie the other end to a paper clip so that the paper clip almost touches the bottom of the jar when the pencilis placed across the top of the jar.
5. Dip the string into the hot solution to wet it.
6. Dip the string into dry sugar to cause a few "seed" crystals to attach to it.
7. Place the string in the jar and place the jar in a spot where it will not be disturbed.
8. Observe the crystal each day (3-10 days).

Questions:

1. How large was the largest sugar crystal? Make a drawing of it.
2. Was the sugar solution saturated or supersaturated?
3. What caused the crystals to grow?

Reaction:

Table sugar is called sucrose $C_{12}H_{22}O_{11}$. When the crystals form, single molecules of sucrose come from the solution and attach to the surface of the sugar crystal to make the crystal larger and larger. Growing crystals helps us to appreciate that substances are made up of single molecules. Solids have many molecules all piled up in a regular arrangements in crystals. In solutions, the molecules that are dissolved are floating around among the water molecules.

Growing Sugar Crystals
(Continued)

The building blocks of crystals are individual particles of that substance. These particles are often ions. The attaction of these positively and negatively charged ions for other ions holds many crystals together. The size of the ions, their charges, the direction in which these attractions are exerted, and the strength of the attraction help determine the shape of the crystal.

As waater evaporates from the solution, the attractive forces between ions, atomsd, or molecules become stronger. Finally, the attraction is strong enough to attach the particles to the surface of the growing crystal. AS this process continues, the crystal becomes bigger.

This same activity can be done using sodium chloride (NaCl), table salt.

MAKING CRYSTALS OF ROCK SALT

Materials needed:

metal jar lid
soil
copper wire
table salt
plastic tumbler
spoon
water
graduated cylinder

Procedure:

1. Half fill a metal jar lid with ordinary soil.
2. Add 25 ml of salt to a tumbler of water. Stir the salt into the water until it is saturated.
3. Pour the clear salt water on the soil.
4. Place a loop of cooper wire on the top of the saltwater mud.
5. Put the jar lid in the sun to dry, or set it aside in a warm place.
6. As the mud dries, observe the crystals of rock salt.

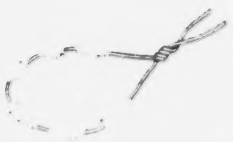
Questions:

1. Why did the salt reappear as crystals that were larger than the salt you started out with?
2. What are some other ways you can grow salt crystals?

Reactions:

Same explanation as activity for growing sugar crystals.

The salt solution was holding all the salt it could. As the water evaporated, the remaining solution could hold less salt. The excess salt must "come out" of the solution. The crystals often start forming around some speck of dust that serves as a "nucleus" for the crystal. The remaining salt that precipitates form around the first crystal. or crystals, taking them as their patter. Hence, larger crystals than the original salt.



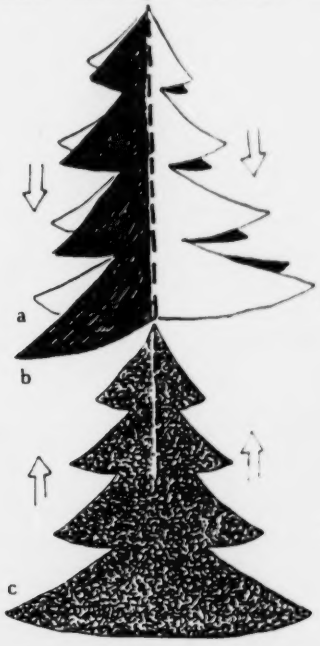
THE CHEMISTREE: ABSORPTION AND EVAPORATION

Materials needed:

blotting paper (green, preferably) or lightweight cardboard
shallow bowl
laundry bluing
table salt
ammonia
food coloring

Procedure:

1. Cut three pieces of blotter paper in the shape of a fir tree. Cut a small slit at the bottom of two pieces and a slit at the top of one piece as shown in the illustration. Each piece should be about 4 in. high. The base should be just small enough to fit into a small shallow dish.



2. Insert pieces a and b on the top of piece c to make a tree.
3. Prepare a special solution containing the folllowing ingredients:
   6 Tbsp. water
   6 Tbsp. laundry bluing
   1 Tbsp. ammonia
   6 Tbsp. table salt
4. Fill the shallow dish with the special solution.
5. Place the base of the tree in the dish so that the tree stand upright.
6. Place 1 drop of food coloring atthe tip of each branch of the tree.
7. Observe the tree for several hours.
8. Explain your observations.

The Chemistree
(Continued)

Reaction:

Crystals of salt dissolve in the solution. These disolved crystals are absorbed with the solution onto the blotter paper and travel up the blotter. Evaporation occurs faster at the edge of the blotter and results in crystal formation.

When the tree is fully formed, remove it from the solution and keep it as a permanent display. Do not let too many crystals form or the tree will collapse.

Several hours may be required for crystals to form on the tree. Molecules of water and salt must move through the blotter. Molecules of water must gain enough energy to leave the solution (evaporation).

COMMON CHEMICALS

Solutions

Osmosis: the movement of a solvent (water) across a semipermeable membrane from an area of lower to higher solute concentration.

Plant and animal cells control nutrient concentrations by osmosis; pickles are made from cucumbers by osmosis; and venous blood plasma enters capillaries because of the effect of osmosis.

Diffusion: the movement of molecules of a substance from an area of relatively high concentration to an area of lower concentration.

Activity: **Osmosis and the Egg Membrane**
demonstrates the movement of water from an area of lower concentration to an area of higher concentration

OSMOSIS AND THE EGG MEMBRANE

Materials needed:

raw egg
vinegar
plastic wrap
2 beakers
clear syrup

Procedure:

1. Place a raw eggin a 250 mL beaker.
2. Fill the beaker with vinegar, and cover it with plastic wrap. Punch a few holes in the wrap.
3. After about 48 hours, notice that the egg shell has "disappeared" and the egg has swollen considerably.
4. Carefully pour off the solution and examine the egg. The membrane is firm enough to allow the egg to be held in the hand.
5. Place the enlarged egg in a second beaker containing a diluted clear syrup solution (50:50).
6. After another 2 days, observe that the egg has "shrunk" to a size much smaller than that of the original egg.

Reaction:

This demonstration shows osmosis, the movement of water across a semipermeable membrane from an area of lower to higher solute concentration.

When placed in vinegar which is 5% acetic acid, the acid reacts with the calcium carbonate in the egg shell.

$$2H^+ (aq) + CaCO_3 (aq) \longrightarrow CO_2 (g) + H_2O (l) + Ca^{2+} (aq)$$

A very high concentration of protein (mostly albumin) exists in the egg. Thus, water enters the egg in an attempt to make the solute concentration equal on both sides of the semipermeable membrane (egg membrane). Thus, the egg gets larger.

When the egg is placed in a syrup solution, a higher solute concentration (glucose) is outside the egg than inside. Thus, the water leaves the egg in an attempt to dilute the more concentrated glucose solution outside. Thus, the egg gets much smaller.

Osmosis is responsible for the movement of small nutrient molecules and water into cells, and for the movement of waste products out of the cell.

COMMON CHEMICALS

Density

Density: mass of a material in a standard volume, such as grams per cubic centimeter. Given by the formula,

$$\text{Density} = \frac{\text{mass}}{\text{volume}}$$

Activity: **Burning Water**
demonstrates that cigarette lighter fluid is less dense than water.

Activity: **Densities of Different Liquids**

Activity: **Figuring the Density**
demonstrates the calculation of density using mass and water displacement.

Activity: **The Mysterious Sunken Ice Cube**
compares the density of water, ethanol, & ice.

Activity: **The Suspended Egg**
demonstrates the density of salt and tap water.

Activity: **Sugar in a Can of Soft Drink**
demonstrates the density of regular & diet Coke.

Activity: **Waves in a Bottle**
demonstrates polar and nonpolar solution with density.

BURNING WATER

Materials needed:

cigarette lighter fluid
flask
water
matches

Procedure:

1. Prior to performing this demonstration, squirt about one-half teaspoon of cigarette lighter fluid in the flask, swirl the flask to distsribute the fluid evenly so that the flask appears to be empty.
2. Take the flask and fill to the top with water from a faucet.
3. For a more dramatic effect, add a pinch of salt from a new box or sodium bicarbonate from a new box (let students see you open the new container).
4. Light the top of the flask. The lighter fluid will have floated to the top of the flask, unobserved by the students.
5. Ask for observations (flame, smoky product, kerosene-like oder, etc.).

Reaction:

The real reaction is that of the sudents as they try to figure out what is going on. With a tongue-in-cheek presentation, the teacher can produce all sorts of reactions. Some students will believe that the water, salt, or baking soda is burning. Others will rely on their own observations and be skeptical; they know that another ingredient must be involved.

The chemical reaction is the combustion of cigarette lighter fluid, a mixture of light hydrocarbons that are "lighter" (less dense) than water.

$$C_6H_{14}(l) + 9\tfrac{1}{2}O_2(g) \longrightarrow 6CO_2(g) + 7H_2O(g)$$

Do not use charcoal lighter fluid.

If too much fluid is used, students will be able to see an "oily" layer, and the effect is lost. Practice to get just the right amount. With larger flasks, more time is required for the fluid to reach the top.

DENSITIES OF DIFFERENT LIQUIDS

Materials needed:

graduated cylinder
water
corn syrup
vegetable oil
glycerine

Procedure:

1. One at a time, slowly pour the water, corn syrup, vegetable oil, and glycerine.
2. Observe the liquids as they form separate layers.
3. Make a sketch showing the order in which the liquids have settles in the graduated cylinder.

Questions:

1. What caused the liquids to separate into layers?
2. Which liquid is the most dense?
3. Which liquid is the least dense?
4. List the four liquids in order from lease to most dense.

FIGURING THE DENSITY

Materials needed:

several small rocks
golf ball
graduated cylinder
water
balance

Procedure:

1. Use a balance to find the masses of the small rocks and a golf ball. Record your measurements in a data table.
2. Fill the graduated cylinder with water to the 50-mL mark.
3. Gently place one rock sample in the water. Notice how much the water level rises. This is equal to the volume of water displaced. Record the volume of the water in your data table.
4. Repeat step 3 with other rock samples and golf ball.

Questions:

1. What is the volume of each rock?
2. What is the volume of the golf ball?
3. Use the information from your data table to compute the density of each sample.

Reaction:

Archimedes observed that when an object is placed in water, it causes the water level to rise. The amount of water that an object replaces is called displacement. The volume of water that an object displaces is equal to the volume of the object. The volume of an irregularly shaped solid can be found by placing the object in water and measuring the volume of water that the object displaces.

Density is equal to the mass divided by volume.

THE MYSTERIOUS SUNKEN ICE CUBE

Materials needed:

2 medium size beakers
ice cubes
water
ethanol
food coloring

Procedure:

1. Before the students arrive, fill two medium-sized beakers three-fourths full - one with water and one with ethanol.
2. Place an ice cube in each beaker when you are ready to perfrom the demonstration.
3. Observe the positions of the ice cubes.
4. After students make an initial observation, add 1 drop of food coloring to each beaker to improve visibility.

Questions:

1. What do we know about the density of the liquids as compared to the ice cubes?

Reaction:

The density of water is 1.00 g/cm^3. The density of ice is 0.92 g/cm^3. The density of ethanol is 0.79 g/cm^3. Since ice is less dense than water, it floats. Ice is more dense than ethanol, and sinks.

Icebergs are floating in seawater - density of 1.03 g/cm^3. An iceberg is 11% exposed. Eighty-nine percent is under water.

THE SUSPENDED EGG

Materials needed:

large graduated cylinder
water
salt
egg

Procedure:

1. Half fill a large graduated cylinder with a concentrated salt solution.
2. Carefully fill the cylinder with water.
3. Slide in an egg.
4. Observe the position of the egg.

Questions:

1. How can we explain the position of the egg?

Reaction:

The egg will remain suspended at the interface since it is less dense than the salt solution and more dense than water.

SUGAR IN A CAN OF SOFT DRINK

Materials needed:

can of soft drink
can of diet variety of same drink
large container
water
watch glass
sugar
double-platform balance

Procedure:

1. Place an unopened can of regular soft drink in a large container filled at least three-quarters with water. Notice that the can sinks to the bottom.
2. Place a can of the diet variety of the same soft drink in the same container or similar container; notice that it floats.
3. Because the volume of each can is the same (12 fluid oz), the difference in density must be due to a difference in the weight of the two cans.
4. Place each of the cans on one platform of a double-platform balance. If you do not have a double-pan balance, first weigh the regular can with a watch glass on the top. Then, with the weights in place, place the diet can with a watch glass on top on the balance pan.
5. Put a watch glass on the top of each can. Notice that the regular can is heavier than the diet can.
6. Slowly add table sugar (sucrose) to the watch glass on the diet can until the weights of the two cans are equal.
7. This is the amount of sugar missing from the diet soft drink and present in the regular variety. Determine the weight of the sugar.

Reaction:

Sugar in the regular variety of soft drink is usually sucrose; however, corn syrup and fructose are often used. Corn syrup is essentially sucrose. Because fructose is much sweeter than sucrose, less is needed to produce a sweet taste.

Typically, a can of diet soft drink contains only about 0.2 g of sugar.

If a regular Coke (Coke Classic) weighs 387.4 g, and a Diet Coke weighs 371.5 g, this could mean that a can of regular Coke contains 16.0 g of sugar or sugar compounds.

WAVES IN A BOTTLE

Materials needed:

1-L clear plastic bottle with lid
distilled water
rubbing alcohol or ethyl alcohol
paint thinner or charcoal lighter fluid
blue food coloring
duct tape

Procedure:

1. Half fill a 1-L clear plastic bottle with distilled water.
2. Add 50 mL of rubbing alcohol.
3. Add paint thinner to fill the bottle to the brim.
4. Add four drops of blue food coloring, one at a time.
5. Place the lid on the bottle and seal it with duct tape.
6. Turn the bottle on its side and rock it to produce waves.

Questions:

1. In which liquid did the food coloring dissolve?
2. Why do the liquids not mix?

Reaction:

Blue liquid creates elegant wave action against a colorless liquid in a plastic soft drink bottle. Water and food coloring solutions are polar. Paint thinner or charcoal lighter fluid are nonpolar and less dense than water.

Beyond the GED with Physical Science
a special project

NAME:_____ Pre-test / Post-test

Directions: Circle the **letter** of the answer you choose.

1. When we use the word **matter** in chemistry we are referring to:
   A. all visible forms of life
   B. anything which can be seen or felt
   C. anything which occupies space and possesses weight
   D. any substance that is not found in living organisms

2. In solid matter, the particles of which it is made are:
   A. loosely packed with no space between them
   B. tightly packed with no space between them
   C. loosely packed with little space between them
   D. tightly packed with little space between them

3. Gases differ from solids in that the gases:
   A. take the shape of their container and are always invisible
   B. have no shape or boundaries
   C. have a definite shape
   D. have definite shape and boundaries

4. A molecule is the smallest particle of:
   A. an atom
   B. an element
   C. a compound
   D. a mixture

5. The simplest forms of matter are substances that cannot be broken down by ordinary chemical change. We call these simple substances:
   A. molecules
   B. elements
   C. properties
   D. particles

6. The four basic properties of matter are mass, volume, weight, and:
   A. luster
   B. temperature
   C. density
   D. shape

7. Which of the following descriptions are chemical properties?
   A. lighter than air and yellow in color
   B. liquid, heavier than air
   C. colorless, soluble in water
   D. reacts with other elements to form oxides

8. Which of the following is **not** a true statement?
   A. All atoms of the same element have the same properties.
   B. Atoms are changed when they are chemically combined with other atoms.
   C. Atoms of most elements can combine with atoms of other elements.
   D. All elements are composed of atoms.

9. The negative charged particle found within the atom is the:
   A. proton
   B. electron
   C. nucleus
   D. neutron

10. An ion is:
   A. one molecule of water
   B. one particle of hydrogen
   C. the same as a neutron
   D. an atom with an electric charge

11. The type of bonding in which atoms share electrons is:
   A. ionic bonding
   B. covalent bonding
   C. nuclear bonding
   D. physical bonding

12. In the modern periodic table, elements are arranged by:
   A. density
   B. atomic number
   C. volume
   D. weight

13. Which of the following substances is a chemical compound?
   A. blood
   B. water
   C. oxygen
   D. air

14. The arrow in a chemical equation means:
    A. yields
    B. and
    C. balances
    D. changes

15. The number of atoms of each element on both sides of a chemical equation must always be:
    A. greater than one
    B. less than two
    C. different
    D. equal

16. The formula for Epsom salts, a medicine is $MgSO_4$. How many different elements are in Epsom salts:
    A. 6
    B. 2
    C. 3
    D. 4

17. Oxygen is an element and so is hydrogen. When two atoms of hydrogen unite with one atom of oxygen:
    A. three atoms of water are formed
    B. one atom of water is formed
    C. two molecules of water are formed
    D. one molecule of water is formed

18. Hydrochloric acid (HCl) is composed of hydrogen and chlorine. A molecule of HCl is formed:
    A. by the union of one atom of hydrogen and one of chlorine
    B. when hydrogen and chlorine are chemically changed into other elements
    C. by the union of water and salt
    D. by the union of molecules of hydrogen and oxygen

19. Sugars and starches are carbohydrates, and are composed of three elements. They are:
    A. carbon, oxygen, and sodium
    B. carbon, sodium, and hydrogen
    C. oxygen, hydrogen, and carbon
    D. hydrogen, oxygen, and chlorine

20. Table salt (NaCl) is composed of the two elements:
    A. oxygen and chlorine
    B. hydrogen and chlorine
    C. sodium and chlorine
    D. carbon and chlorine

21. Atoms that are neutral contain:
    A. only five electrons and protons
    B. an equal number of electrons and protons
    C. more protons in the nucleus than electrons in orbit around the nucleus
    D. fewer protons than electrons

22. If the atomic number of an element is fourteen, then we know there are:
    A. fourteen nuclei in each atom
    B. fourteen electrons and no protons
    C. fourteen protons in its nucleus and fourteen orbiting electrons in each atom
    D. seven protons in its nucleus and seven orbiting electrons

23. Isotopes are used in diagnosis and treatment of various diseases; An isotope of chlorine is an atom of chlorine that:
    A. has a different atomic mass than another atom of chlorine
    B. is chemically less potent than an atom of natural chlorine
    C. has different chemical properties than an atom of chlorine in its natural state
    D. has a different atomic number than a more stable atom of chlorine

24. If a substance is changed so that its composition is permanently altered and a new and different substance is formed, we refer to this as a(n):
    A. biological change
    B. physical change
    C. chemical change
    D. anatomical change

25. The amount of water that an object displaces is equal to the object's:
    A. mass
    B. weight
    C. volume
    D. density

26. A person is more buoyant when swimming in salt water than in fresh water because:
    A. the person keeps his head out of salt water
    B. salt water has great tensile strength
    C. salt coats the person's body with a floating membrane
    D. salt water is more dense than fresh water

27. A ship floats because it:
    A. is made of dense material
    B. has a high specific gravity
    C. is less dense than air
    D. displaces a weight of water greater than or equal to its own weight

28. Which of the following properties is considered a physical property?
    A. flammability
    B. boiling point
    C. reactivity
    D. osmolarity

29. Acid and bases are called chemical opposites because they:
    A. are compounds of completely different elements
    B. have no properties in common
    C. have different functions in the body
    D. react with and tend to neutralize one another

30. The mild acid that is in vinegar is called:
    A. boric acid
    B. acetic acid
    C. citric acid
    D. lactic acid

31. The term pH expresses the:
    A. density of a solution
    B. proportion of solute to solvent
    C. degree of pressure exerted by the blood
    D. degree to which a solution is acidic or basic

32. The pH of a neutral solution is:
    A. 0
    B. 7
    C. 10
    D. 14

33. Solvents may be in the form of:
    A. liquids
    B. solids
    C. gases
    D. all of these

34. A semipermeable membrane is one which allows passage of:
    A. the solute but not the solvent in a solution
    B. both the solute and the solvent
    C. the solvent but not the solute

35. When diffusion occurs the molecules of a substance move from an area of:
    A. relatively high concentration to one of lower concentration
    B. concentration equal to that of the area to which it is moving
    C. relatively low concentration to one of higher concentration

36. A solution that contains all the solute it can normally dissolve at a given temperature must be:
    A. concentrated
    B. supersaturated
    C. saturated
    D. unsaturated

37. When dried fruits or vegetables are soaked in water they become saturated with water. This is an example of:
    A. osmosis
    B. diffusion
    C. filtration

38. Both osmosis and diffusion:
    A. remove liquid from an area of dehydration
    B. equalize the concentration of various solution in an area
    C. prevent the free flow of solutions from one area to another

39. The path that an electron follows around the nucleus is called:
    A. electron shell
    B. ionic bonding
    C. gravitational pull
    D. surface tension

40. The electron shell that is closest to the nucleus of the atom is complete when it contains:
    A. one electron
    B. two electrons
    C. eight electrons
    D. eighteen electrons

Questions adapted from:
Gooding, M. F. (1991). ARCO Nursing school entrance examinations (11th ed.). New York: Prentice Hall.
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Pre-test / Post-test

Answer Key

1. C
2. D
3. B
4. C
5. B
6. C
7. D
8. B
9. B
10. D
11. B
12. B
13. B
14. A
15. D
16. C
17. D
18. A
19. C
20. C
21. B
22. C
23. A
24. C
25. C
26. D
27. D
28. B
29. D
30. B
31. D
32. B
33. D
34. C
35. A
36. C
37. A
38. B
39. A
40. B

Beyond the GED Physical Science

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BEYOND THE GED WITH PHYSICAL SCIENCE

Final Report

BEYOND THE GED WITH PHYSICAL SCIENCE

A hands-on science curriculum

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Project Director & Curriculum Developer

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A 353 Special Project of
Pennsylvania Department of Education

July 1, 1993 to June 30, 1994

Project Number: 98-4024

Funding: $11,604

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Beyond the GED With Physical Science

F I N A L R E P O R T

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ABSTRACT

Title: **Beyond The GED With Physical Science**

Project Number: 98-4024 **Funding:** $11,604

Director: Rachel Martin **Phone:** (412) 662-3000
Contact Person: Karen Hande.nan **Phone:** (412) 662-3000

Agency Address: Mercer County Area Vo-Tech School
P.O. Box 152, 776 Greenville Road
Mercer, PA 16137

Purpose:

This project approached the problem of educational deficiencies in the study of physical science for students working at the GED level by developing and implementing a hands-on science curriculum.

Procedure:

A needs assessment was conducted and an outline of curriculum objectives was established. Available instructional material was reviewed and additional material was developed. A hands-on science curriculum was designed and field tested. A few modifications were necessary and a second field test was conducted.

Summary of Findings:

This project proved to be helpful in expanding the science knowledge of the students, as well as increasing their level of confidence in the area of chemistry. Students showed an increase in scores on a pre/post test.

Comments:

This curriculum can be incorporated into any science program with very few modifications. Most activities require only general grocery store or kitchen items making this curriculum suitable for a variety of locations and agencies.

Products:

Hands-on Science Curriculum & Final Report

INTRODUCTION

The project entitled BEYOND THE GED WITH PHYSICAL SCIENCE addressed the problem of educational deficiencies in the area of physical science for students working at the GED level. A hands-on physical science curriculum was developed with an emphasis on chemistry and the skills necessary to continue academic training beyond the GED. The goal of the project was to better equip students with a science background so they may be successful in college courses or other courses necessary to meet their educational and career goals.

PROJECT DESIGN

A needs assessment was conducted of current GED level students to determine their academic goals and their need for additional instruction in the area of physical science. An outline of curriculum objectives was established after reviewing two nursing school entrance examination books and a discussion with the director of Practical Nursing at the Mercer County Vo-Tech School. A pre-post test was designed for the purpose evaluating the curriculum objectives.

After reviewing available instructional materials and developing additional materials, a hands-on physical science curriculum was designed. The curriculum is divided into four units that are outlined by objectives. Each unit contains content area supported with many activities, demonstrations and experiments so the learner is an active participant. This curriculum can be used as a course by itself or as a supplement to another science class.

The curriculum was first field tested with eight students in November/December and then a second field test was conducted in February/March with six students. Each group of students received 72 hours of instruction in the area of physical science and showed a considerable improvement in pre-post test scores. A few modifications to the curriculum were necessary due to a few problems with experiments and supplies.

ADMINISTRATION

The project entitled BEYOND THE GED WITH PHYSICAL SCIENCE was supervised by Clayton Sheasley, Assistant Director in charge of Adult Education at Mercer County Area Vocational-Technical School. The project director and curriculum developer was Karen Handerhan. The instructor for field testing the curriculum was Janet Smoker.

OBJECTIVES / RESULTS

Objective #1 to assess the needs of GED level students. This objective was met by an informal evaluation of the academic goals of GED students wishing to continue their education beyond the GED. A needs assessment was conducted to determine if additional instruction in the area of physical science would be useful to the students.

Objective #2 to review and evaluate available instructional materials, and develop additional materials. This objective has been met by reviewing various resource materials for physical science and chemistry and developing activities. Curriculum objectives were designed after reviewing two nursing school entrance examination books.

Objective #3 to design and write curriculum guide. Four units of instruction have been developed to meet this objective. Each unit contains content area and many activities, demonstrations, and experiments to keep the students actively involved in the learning process.

Objective #4 to test curriculum and modify as needed. The curriculum has been field tested with only 14 out of the proposed 24 students. Recruitment efforts included in-house memos and letters to all adult education instructors and counselors, as well as letters and posters sent to local agencies serving the

Dept. of Welfare, IU #4, Urban League, JTPA). The science program as also published as a news release in the local papers. The participating students said they enjoyed the program and it was very helpful to them. The students involved in the field testing showed a considerable increase in test scores from the pre-post tests.

Objective #5 to disseminate curriculum guide on a statewide level. This objective will be met by the completion of this report and the curriculum that follows.

EVALUATION

This project received a positive internal evaluation by all staff and students involved. Students completed daily evaluation forms rating and commenting on the lessons and activities. Repeatedly the students rated the activities favorably and made comments such as "very interesting and helpful", "thoroughly enjoyed class - excellent", and "learned a lot and had a lot of fun". The students also completed a program evaluation form (example attached) with the following results:

Program Content	average score
(material content)	9.6
Program Presentation	
(way material was presented)	9.7
Relevance	
(meaningful to you)	9.7
Overall rating	9.9

This project proved to be very helpful in expanding the science knowledge of the students as well as increasing their level of confidence in area of chemistry. The students were very appreciative of the program and were pleased with their progress.

Upon the completion and dissemination of the final report, this project will have successfully met the proposed objectives as previously stated.

BEYOND THE GED WITH PHYSICAL SCIENCE
a special project

Program Evaluation Form

Please evaluate this special project by circling a number for each of the items below.

1 = disappointing
3 = marginal
5 = okay
7 = very good
10 = excellent

Program Content 1 2 3 4 5 6 7 8 9 10
(material covered)

Program Presentation 1 2 3 4 5 6 7 8 9 10
(way material was presented)

Relevance 1 2 3 4 5 6 7 8 9 10
(meaningful to you)

Overall rating 1 2 3 4 5 6 7 8 9 10

How could this program be improved?

Comments:

CONCLUSION

It was the goal of this project to promote physical science skills through active participation by all learners. This curriculum can be incorporated into any science program with very few necessary modifications. Most of the activities require only "kitchen" or "grocery store" items making the curriculum suitable for a variety of locations and agencies. Although this curriculum was designed with the target audience being GED level students, the lessons can be simplified for all learners regardless of their ability levels.

Beyond the GED With Physical Science

Unit One - INTRODUCTION TO CHEMISTRY - Objectives

Matter:

1. Define matter.
2. Name some common elements and compounds.
3. Distinguish among elements, compounds, and mixtures.

Physical Properties:

4. Describe the three phases of matter.
5. Relate the phases of matter to the arrangement of particles within the matter.
6. Describe the energy changes that occur during changes of phase.
7. Describe what occurs at the freezing point, melting point, and boiling point of a substance.
8. Explain the affects of atmospheric pressure, the relationship between pressure and volume, and the relationship between pressure and temperature.
9. List the standard physical properties of matter.
10. Explain surface tension.

Physical/Chemical Changes:

11. Distinguish between a chemical change and a physical change.
12. List various types of physical changes.
13. Contrast a solution and a suspension.

Physical/Chemical Changes:

14. Distinguish between solute and solvent in a solution.
15. State the law of definite composition.
16. Describe the energy changes in a chemical reaction.
17. Explain the rate of reaction.
18. Give examples of variables that affect the rate of reaction.
19. Define catalyst.

Beyond the GED With Physical Science

Unit Two - INTRODUCTION TO ATOMIC STRUCTURE - Objectives

Atoms and Molecules:

1. Define an atom and a molecule.
2. Contrast the properties of atoms with the compounds formed.

The Atom's Structure:

3. Distinguish among proton, neutrons, and electrons.
4. Define atomic number, mass number, and isotopes.
5. Describe or draw Bohr's model of the atom.

The Atom in Chemical Changes:

6. Define valence electron.
7. Explain why atoms give and take electrons.
8. Contrast metal, nonmetal, metalloid, and noble gas elements.
9. Define an ion.
10. Distinguish between an ionic bond and a covalent bond.

The Periodic Table of the Elements:

11. Define a family of elements.
12. Describe how the periodic table is arranged.

The Periodic Table of the Elements:

13. Obtain information about elements and their atoms from the periodic table.
14. Locate metals and nonmentals on the periodic table.
15. Locate the inert gases on the periodic table.

Beyond the GED With Physical Science

Unit Three - CHEMICAL FORMULAS & EQUATIONS - Objectives

Writing Chemical Formulas:

1. Identify element symbols.
2. Explain a chemical formula.
3. Distinguish a subscript from a coefficient.

Writing Chemical Equations:

4. Interpret the information contained in a chemical equation.
5. Balance equations.
6. Explain diatomic molecules.

Beyond the GED With Physical Science

Unit Four - COMMON CHEMICALS - Objectives

Acids and Bases:

1. List the characteristics of acids and bases.
2. Describe how indicators are used to identify acids and bases.
3. Explain why some acids and bases are strong and others are weak.
4. Outline the pH scale.
5. Define the neutralization reaction.

Solutions:

6. Describe the characteristics of a solution.
7. Identify the parts of a solution.
8. Define solubility.
9. Distinguish between saturated, unsaturated and supersaturated solutions.
10. List the factors that affect the solubility of a material and the rate at which it dissolves.
11. Explain osmosis and diffusion.
12. Define semipermeable membrane.

Density:

13. Define density.
14. Explain how to find the density of a solid or liquid.
15. Define displacement.